ENVIRONMENTAL WORKING GROUP



Clearcut Disaster: Carbon Loophole Threatens U.S. Forests

By Mary S. Booth PhD

with

Richard Wiles

Senior Vice President

Environmental Working Group

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www.ewg.org

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Executive Summary

House and Senate climate legislation, as well as federal and state policies designed to promote the use of biomass fuels for electricity generation, will sharply increase cutting of U.S. forests by the year 2025 while pouring huge amounts of carbon into the atmosphere, an extensive analysis by Environmental Working Group (EWG) shows.

biomass-fueled electricity generation will produce billions of tons of uncounted CO_2 emissions over the next 15 years while wiping out millions of acres of woodlands

Reaching these goals – generating 25 percent of US electricity from renewable sources by 2025 – will require the equivalent of clear-cutting between 18 and 30 million acres of forests over the next 15 years; 30 million acres is 46,291 square miles, an area larger than the entire state of Pennsylvania. By 2030, the equivalent of up to 50 million acres could be clear-cut as utilities become dependent on biomass to meet their renewables targets. Less intensive harvesting merely means that more acres that will be cut.

This perverse outcome of pending climate and energy bills and existing state and federal renewable energy incentives results from a glaring flaw in carbon accounting practices, which falsely assumes that burning biomass fuels, including trees, produces zero net carbon emissions. Close examination shows that the reverse is true: logging and burning trees will produce a near-term surge in carbon releases – greater than from burning coal – while eroding for decades the forests' ability to recapture those emissions.

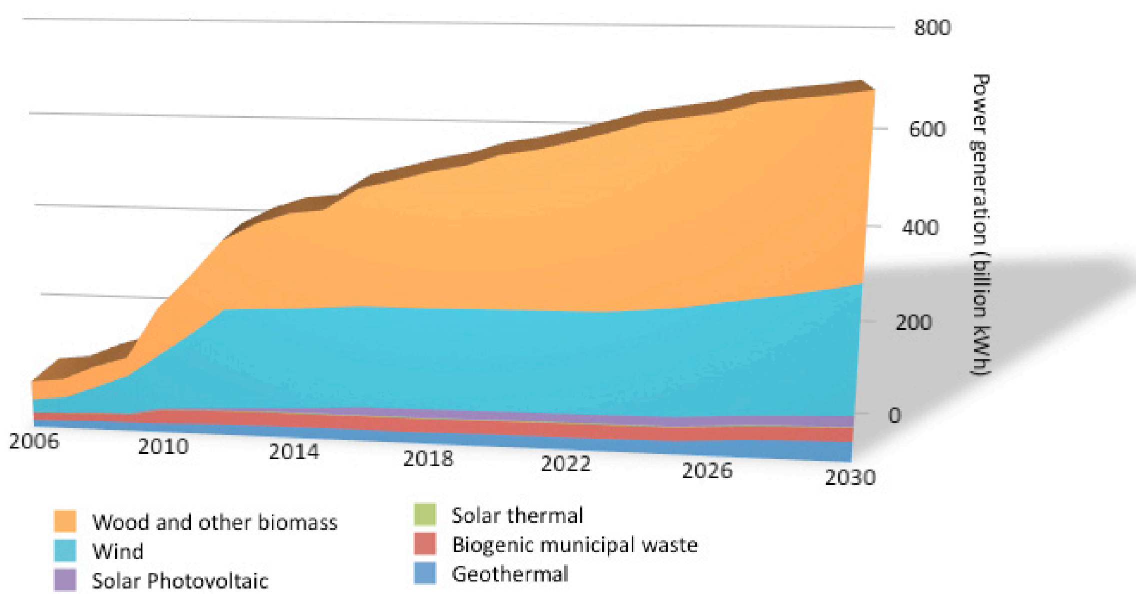
This Enron-style accounting system, embedded in virtually all climate policies worldwide, hides massive carbon emissions that will result from burning biomass to generate electricity. EWG's analysis of government projections predicts that over the next 15 years about 4.7 billion tons of carbon will be generated from burning biomass, most of it from whole trees and all of it "off the books." This massive pulse of uncounted carbon dioxide will effectively erase 80% of the reduction in CO_2 emissions from the power sector that is at the heart of federal climate legislation.

Adding insult to injury, this destruction and pollution will be heavily subsidized by U.S. taxpayers. The Congressional Budget Office estimates that under the American Clean Energy and Security Act (ACESA), the treasury would forfeit about $10.5 billion in tax revenues over the next 15 years as we subsidize the construction of biomass-burning power plants, most of them burning whole trees. Because biomass emissions are not counted, facilities generating power from biomass would avoid purchasing carbon allowances worth a staggering $129 billion by 2025 under the carbon cap.

EWG's analysis examined two scenarios using data and projections from the Energy Information Administration (EIA) of the U.S. Department of Energy. We analyzed the impact on forests of EIA's basic scenario, which projects the impact of the House-passed climate bill (ACESA) if enacted as written, and second ACESA scenario that achieves maximum carbon reductions. Our analysis indicates that meeting the demand for biomass fuel under EIA's basic ACESA scenario would require the equivalent of cutting between 18 and 30 million acres by 2025, and up to 50 million acres by 2030. The fuel requirement for the even faster ramp-up of biomass power envisioned under the optimal scenario would require the equivalent of cutting up to 59 million acres by 2025. Legislation proposed in the Senate would produce essentially the same results.

Over the past decade, many states have adopted renewables portfolio standards (RPS)[1] under which a certain proportion of power must be produced from renewable sources. One potentially disastrous outcome of these policies, even prior to enactment of a federal RPS, has been an explosion of proposals to construct wood-burning power plants and to burn wood at coal-fired plants (co-firing). Some existing coal plants are proposing to switch to burning wood entirely, which under current policy would allow them to declare that their carbon dioxide emissions have gone to zero, when in reality they would have increased substantially.

Figure 1. Biomass burning will increase dramatically under federal renewables incentives



Trees and other biomass fuels account for 55 percent of renewable power by 2025 under the basic ACESA scenario (includes end-use generation and excludes conventional hydropower). Under current policies, all carbon emissions from biomass burning are off the books. (Source: EIA National Energy Modeling System Run HR2454CAP.D072909A)

At least 118 new biomass power plant and co-firing proposals that would use wood as fuel are currently in various stages of permitting or approval in at least 30 states, with capacity increasing at an exponential rate.

1 Also known as renewable electricity standards (RES)

"Hardly a day passes in the Southern U.S. without an announcement of a new bioenergy facility or expansion of an existing one… What is increasingly obvious is that the amount of truly available logging residues will be nowhere near enough to supply the current and announced bioenergy processors in the Southern U.S…"

Biomass Magazine
August 2009

A typical 50-megawatt biomass plant burns more than a ton of wood a minute. Two wood-burning plants recently proposed in Massachusetts would generate a combined 97 MW and require the equivalent of cutting 12,000 acres of forest annually, more wood than is currently harvested in the entire state each year, while providing just 0.7 percent of the power generated in the state. Permitting documents reveal that whole-tree harvesting would provide one-half to two-thirds of the fuel for at least one of the plants.

In response to objections by citizens and environmental groups, Massachusetts recently suspended the eligibility of biomass for the state's renewables portfolio standard pending a complete review. In Ohio, multiple proposals to co-fire biomass in coal plants have been proposed. Plant operators admit that whole trees, specifically white, interior trunk wood, are the only biomass fuel that will meet emissions requirements. The 1,125 megawatt Beckjord plant in Ohio has proposed to replace up to 100 percent of its coal consumption with biomass. Where will this fuel come from?

"The most likely initial fuel will be woody biomass produced by whole tree chipping" from a 50-mile radius of a coal loading terminal on the Big Sandy River.

Beckjord application to the
Ohio Public Utilities Commission - 2009

Many co-firing proposals rely on processed wood pellets for biomass fuel, which require massive energy and wood inputs to produce.

The assumption that burning biomass, including trees, produces zero carbon emissions is the cornerstone of current state-level renewables electricity standards, pending energy legislation in the US Senate and the House-passed climate bill. The erroneous classification of biomass power as carbon neutral has allowed biomass power to emerge as a significant potential source of "renewable" power, even as the overwhelming experience to date indicates that the primary source of biomass will be whole trees.

Without the biomass accounting loophole, many of the carbon reduction goals in federal climate and energy legislation are simply not attainable. Given the massive ramp-up in biomass power that is already occurring, and that 2025 emissions reductions targets must be met in only 15 years, it is urgent to correct this carbon accounting flaw.

Projecting the impact of congressional climate change bills.

A central goal of congressional climate initiatives is to provide up to 25 percent of the nation's power from renewable sources by 2025 and to cut carbon emissions to 17 percent below 2005 levels by 2020.

To do this, the House-passed ACESA bill relies on dramatic increases in renewable energy sources, more than half of which will be biomass. The bill defines biomass renewable fuels, among other things, as "trees, logging residue, thinnings, cull trees and brush..." [Title I, Section 101(b)(16)(H)(i)]

The American Power Act, proposed in the Senate, defines renewable biomass as "renewable plant material, including … other plants and trees" and defines "excess biomass" as including "trees or tree waste on public land." [American Power Act, S. xx, 111th Cong., § 2002 (2010) (amending Title VII of the Clean Air Act (42 U.S.C. 7401 et seq.) as added by American Power Act § 2001, by adding § 700 (44)]

As discussed throughout this report, heavy reliance on biomass will translate into millions of acres of forests being cut to fuel electric power plants. Burning trees generates more carbon pollution than coal, but under EPA's flawed carbon accounting system, the carbon emissions from this cutting and burning of America's forests will count as zero. As a result, the 2020 emissions targets will be met only on paper, not in reality.

In its projections of the impact of the ACESA, the Energy Information Administration (EIA) includes several alternative policy scenarios. We analyzed two EIA scenarios in writing this report.

EIA's "basic" scenario projects emissions reductions if ACESA is enacted into law as passed. Under this scenario, biomass power would constitute 55 percent of renewable power, excluding hydropower, and about 8 percent of total power generation in 2025. Our analysis shows that 18 million acres of forests would be cut to meet the biomass targets projected by EIA in this scenario. Carbon emissions from the power sector would be 17 percent higher than projected because the government assumes that burning trees releases no carbon dioxide into the atmosphere.

Uncounted carbon emissions would be even higher under the second scenario that disallows international carbon offsets, a distinct possibility given the increasingly tenuous credibility of these projects. This scenario forces power plants to reduce carbon emissions directly, producing significant reductions by 2025, but this is accomplished in part through an immediate and massive ramp-up in biomass co-firing (burning trees) at coal plants. The other notable carbon reduction assumption in this scenario is a 230 percent increase in nuclear power by 2030.

Under this scenario, biomass would provide 11 percent of all power generation and 46 percent of renewable power in 2025. About 30 million acres of forest would need to be cut to fill this demand. When the pollution from burning trees is put back on the books, cumulative carbon emissions from the power sector by 2025 are 35 percent higher than EIA projects.[2]

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2 EIA's emissions projections for the power sector include the assumed effect of carbon capture and storage technology (CCS), which is assumed to be operational starting in 2016 (Source: EIA National Energy Modeling System runs HR2454CAP.D072909A, HR2454NOINT.D072909A). To estimate the proportion of total power sector emissions that biomass power would contribute, we estimate biomass emissions relative to total power sector emissions with CCS emissions added back in.

Conclusions and Recommendations

Federal and state carbon tracking systems do not accurately account for carbon emitted by biomass power or place any restrictions on burning whole trees. The rush is on to capitalize on this lucrative loophole, with drastic consequences for forests.

Forests are a major force pulling carbon out of the atmosphere. The annual aboveground growth alone in US forests counteracts about 14 percent of all emissions from power generation each year. Cutting them down to burn in power plants will not only inject massive amounts of stored carbon into the atmosphere, it will also destroy our best defense against the buildup of atmospheric carbon.

To avert this potentially devastating outcome, carbon accounting needs to be reformed, and renewable fuels and greenhouse gas reduction policies need to be aligned accordingly. Specifically:

Pass a strong climate bill.

Congress must enact strong climate legislation that eliminates the biomass carbon accounting loophole. Carbon accounting practices must be corrected to include the full and immediate impact of cutting down forests to burn in biomass power plants. Biomass burning must not be permitted unless each specific proposal can unequivocally demonstrate that it will not increase greenhouse gas emissions, even in the short term. These reforms must be incorporated into all federal and state energy and climate policies.

Require biomass power plants to purchase emission allowances.

Biomass plants should be added to the list of "covered entities" required to purchase carbon emission allowances under federal and regional cap-and-trade programs. To the extent that biomass emissions are demonstrably re-sequestered in a short period of time, exceptions could be made.

Eliminate federal and state incentives for biomass power.

The federal production tax credit for biomass systems that burn whole trees, meaning chipped or pelletized whole trees, must be eliminated. The tax credit provides a massive federal subsidy for forest exploitation. Likewise, the Biomass Crop Assistance Program (BCAP) program providing matching funds to biomass suppliers should be revised to exclude funding of any facilities or operations that encourage forest cutting.

Exclude utility-scale biomass and co-fired coal plants from renewables portfolio standards.

Only high efficiency, small-scale, combined heat-and-power plants that extract maximum energy value from "additional" biomass should be considered to sell Renewable Energy Credits, and such projects should also undergo rigorous lifecycle analysis to determine their carbon footprints. "Additional" biomass should be defined as sustainably generated biomass containing carbon that would not otherwise remain stored, or become stored, or be meaningfully used for purposes other than energy production.

FULL REPORT

I. Biomass Power: Forests to Fuel

More than 50 percent, perhaps far more, of the renewable power generation promoted by federal programs and legislation now under consideration by Congress will come from burning trees and other "biomass" materials.[3]

Biomass power is considered a renewable and carbon-neutral form of electricity generation because it is assumed to utilize the non-marketable parts of trees (like the tops and branches generated by logging) and the non-food portions of agricultural crops (like the stalks of corn and wheat plants). Because these "residues" left after harvesting emit carbon dioxide during decomposition, burning them is considered to produce no more carbon dioxide than would be emitted if they were left in place.

In theory, regrowth then locks up as much atmospheric carbon dioxide into new biomass as was released by combustion. Once this cycle is completed, the power generated by burning biomass is considered to be effectively "carbon neutral,"[4] since the fossil fuel emissions associated with biomass harvesting and transport are generally disregarded.

Until recently, this theory had been widely accepted, and most carbon accounting schemes do not count or regulate emissions from biomass power.[5] This convention has made biomass power an attractive option for meeting state-level "Renewables Portfolio Standards" (RPS)[6] as well as the proposed renewables standard at the heart of federal climate legislation, including the American Clean Energy and Security Act (ACESA) passed by the House of Representatives in 2009.

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3 Many forms of material can be defined as biomass, including old tires, chicken waste, and chicken carcasses. Much of the power generated at existing biomass plants comes from "wood liquors," by-products of the pulp and paper industry, as well as sawmill and other wood-processing waste. However, most new biomass plants utilize wood as fuel. Woody biomass fuels are derived from non-marketable whole trees as well as: leftover branches and tops cut during forestry operations; sawmill waste; urban tree trimming; trees and stumps dug out of the ground during land clearing; and construction and demolition waste. These materials are in limited supply, however, meaning that forest cutting will increase in response to new demand.

4 The Environmental Protection Agency grants biomass energy special status not only as a renewable but also as a "green power source," defined as a power source that produces electricity "with an environmental profile superior to conventional power technologies [that] produce[s] no anthropogenic (human caused) greenhouse gas emissions." (http://www.epa.gov/greenpower/gpmarket/index.htm). The Agency acknowledges that biomass produces biogenic emissions but states that these are "balanced by the natural uptake of CO_2 by growing vegetation, resulting in a net zero contribution of CO_2 emissions to the atmosphere." The Agency's new rules on emissions reporting require that biogenic carbon emissions be reported separately from other emissions. (Environmental Protection Agency, 2009. Mandatory reporting of greenhouse gases; final rule. 40 CFR 86,87,89 et al. Federal Register, October 30, 2009.)

5 See below for an explanation of how the "accounting error" that ignores biomass emissions originated.

6 Currently, 42 States and the District of Columbia have enacted an RPS or similar renewable energy requirement (http://www.dsireusa.org/summarytables/rrpre.cfm)

biomass-fueled electricity generation would produce billions of tons of uncounted emissions while wiping out millions of acres of woodlands

A closer examination of data and projections by the U.S. Department of Energy's own Energy Information Administration (EIA)[7] reveals that this analysis is profoundly flawed. Environmental Working Group (EWG) studied this publicly available but largely unexamined data, and our research reveals that policies based on these assumptions would have drastic consequences. EWG's analysis, based on the government's own data, shows that most biomass-fueled electricity generation would produce billions of tons of uncounted emissions over the next 15 years while wiping out millions of acres of woodlands and eroding for decades the ability of existing forests to sequester atmospheric carbon.

This outcome requires a thorough rethinking of all legislation and proposals that promote biomass-based renewable fuels as a means to achieve energy independence and combat global warming.

ACESA seeks to increase the market share of renewable electricity generation to 25 percent by 2025, although the actual percentage may be as low as 17 percent when exemptions are taken into account.[8] EIA projects that biomass will generate 55 percent of all renewable electricity in 2025.[9]

entire forests can be cut to provide biomass fuel and still be considered "carbon neutral."

Biomass power is simply not carbon neutral. Even where existing logging residues are the sole source of fuel, the assumption that burning these materials emits no more carbon dioxide than natural decomposition fails to acknowledge that decomposition, like regrowth, is a slow, even decadal process, while burning releases greenhouse gases instantaneously. Even more significantly, biomass power is considered equally "climate friendly" whether whole trees or logging residues are used for fuel; in other words, an entire forest can be clear-cut to provide biomass fuel and still be considered "carbon neutral."[10]

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7 The Energy Information Administration, a division of the Department of Energy, uses the National Energy Modeling System (NEMS) to project power sector development under various legislative scenarios. Modeling to describe the growth of both renewable and conventional power generation under ACESA was published in 2009.

8 According to documentation from the Energy Information Administration, "The level of renewables required to comply with the RES (renewable electricity standard) will be lower than the nominal target because of the exemptions and baseline adjustments. While the nominal share in 2025 is 25 percent, exempting the small retailers lowers the effective target to 22 percent of total electricity sales. The effective target is lowered further to 21 percent when the generation from hydroelectric power and municipal solid waste is removed from the sales baseline. The effective target will be lowered still further by the degree to which qualifying energy efficiency credits are used. If States are able to take full advantage of the energy efficiency credits, using them to meet up to 20 percent of the RES requirement, the effective share of renewables required could drop to approximately 17 percent of total electricity sales." (Energy Information Administration. Impacts of a 25-percent renewable electricity standard as proposed in the American Clean Energy and Security Act Discussion Draft. SR/OIAF/2009-04. April, 2009. Washington, DC.)

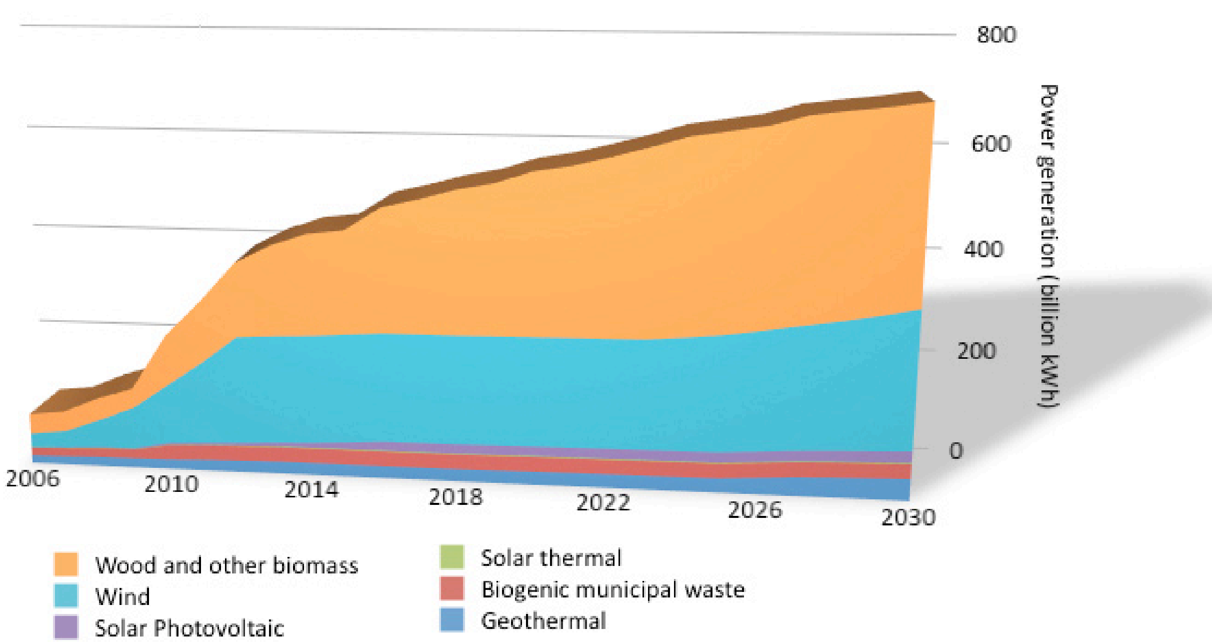
9 This figure includes end use generation, power generated on site by commercial and industrial users.

10 Johnson, E. 2008. Goodbye to carbon neutral: getting biomass footprints right. Environ Impact Asses Rev, doi:10.1016/j.eiar.2008.11.002; Searchinger, T., et al. 2009. Fixing a critical climate accounting error. Science 326: 527 - 528.

II. Promoting "Renewable" Energy: Surprising Consequences

Modeling by the Energy Information Administration projects that under a federal Renewables Portfolio Standard, renewables-based generation will constitute an increasing percentage of total power generation, with a goal of reaching 25 percent by 2025, although exemptions from RPS rules will lower the actual share to about 17–to-19 percent under the various scenarios modeled by EIA.[11] EIA's "basic" scenario, which projects the impacts of ACESA if it were implemented as written, predicts that biomass power will provide about 8 percent of total power generation and about 55 percent of all renewables-based generation,[12] excluding hydropower, by 2030.

Figure 1. Biomass burning will increase dramatically under a federal renewables standard



Projected development (in billion kilowatt-hours), excluding conventional hydropower, in EIA's "basic" scenario for renewable power deployment under ACESA. Scenario includes end use generation

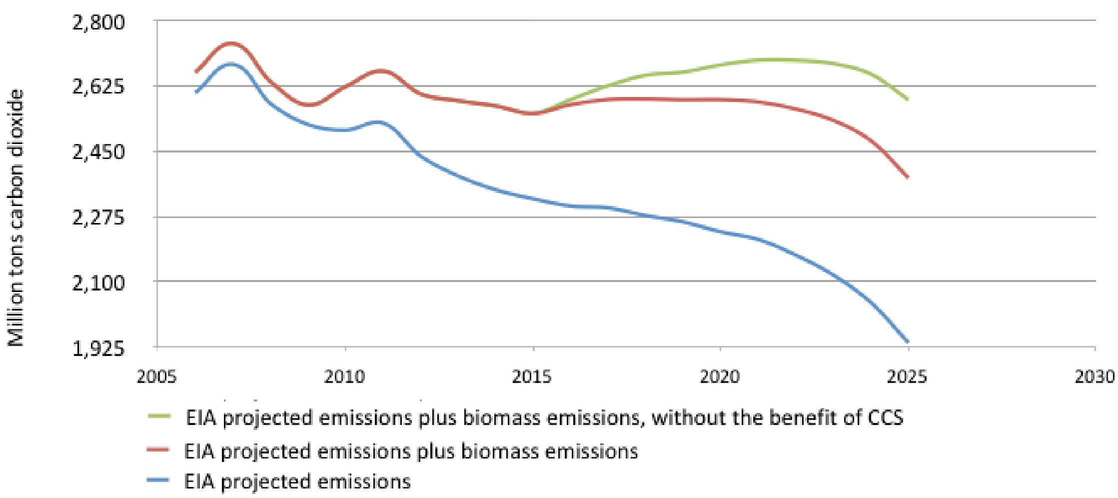
11 See footnote 9 for an explanation.

12 Energy Information Administration. 1990 – 2008 Net generation by state by type of producer by energy source (EIA 906) (available at http://www.eia.doe.gov/cneaf/electricity/page/capacity/capacity.html). "Renewable" power sources defined as wind, solar, and geothermal. The second largest source of renewable power under the EIA scenario is wind power. Deployment of wind power is constrained by a number of factors, including wind speed, limitations on development in reserved and inaccessible areas, and transmission costs. In fact, EIA projects that enactment of federal RPS will do little to incentivize wind power development beyond what is predicted to occur as a result of incentives included in the 2009 American Recovery and Reinvestment Act (ARRA). (Energy Information Administration. Impacts of a 25-percent renewable electricity standard as proposed in the American Clean Energy and Security Act Discussion Draft. SR/OIAF/2009-04. April, 2009. Washington, DC)

Biomass burning will increase greenhouse gas emissions

Between 2010 and 2025, EIA predicts greenhouse gas emissions from the power sector will decline significantly, in part due to a reduction in the amount of power generated by coal. But this decline also depends on the assumption that biomass produces no net carbon emissions, as well as on carbon capture and sequestration, which is assumed to become operational around 2016. When true biomass emissions are counted, it turns out that the majority of greenhouse gas reductions are an artifact of the carbon accounting loophole (Figure 2).[13] The relatively small amount of power produced from biomass has a disproportionate effect on carbon emissions because biomass power produces much more carbon dioxide "at the stack" per unit of energy than coal or natural gas.[14]

Figure 2. Counting biomass emissions eliminates projected emissions reductions



Power sector emissions (million tons carbon dioxide) for the United States, 2006 to 2030. EIA's totals (blue line) do not include biomass emissions but assume that carbon capture and storage (CCS) can start in 2016, reducing emissions by 26 percent from 2006 levels. Adding projected biomass emissions to emissions totals (red line) results in a decline of only 11 percent. Adding biomass emissions and emissions assumed to have been sequestered using CCS (green line) results in a decline of just 3 percent. Stack emissions from biomass are only part of the story, as they do not include emissions from harvest and transport, soil emissions following harvesting disturbance or lost forest carbon uptake. (Source for EIA projection: EIA National Energy Modeling System run HR2454CAP. D072909A).

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13 Biomass power stack emissions were calculated by estimating the amount of fuel required to meet EIA's projections of biomass power generation, using EIA's conversion factors for BTUs in biomass to kilowatt-hours of power. Carbon content was assumed to be 50 percent for wood and 45 percent for agricultural residues, following the convention used by Oak Ridge National Laboratory (http://bioenergy.ornl.gov/papers/misc/energy_conv.html). Our approach to estimating CO_2 emissions from biomass is identical to that used by EPA (Environmental Protection Agency, 2009. Mandatory reporting of greenhouse gases; final rule. 40 CFR 86,87,89 et al. Federal Register, October 30, 2009.)

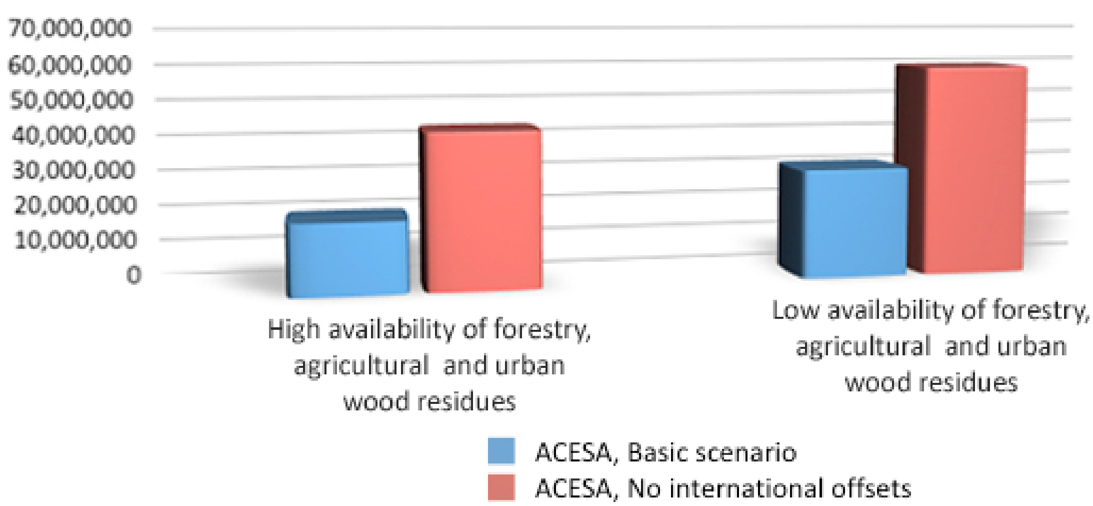
14 Stack emissions are only part of the lifecycle emissions of forest harvesting, which include fossil fuels used for harvest and transport, lost carbon sequestration and soil disturbance following logging. A recent study suggests soil carbon losses following harvesting can be substantial, comprising on average 8 percent of soil carbon, which itself comprises about two-thirds of forest carbon (Nave et al, 2010. Harvest impacts on soil carbon storage in temperate forests.Forest Ecology and Management, 259:857 – 866.)

In addition, EIA's estimates do not take into account fossil fuels consumed during biomass harvesting and processing. Wood chips are a bulky material for the energy they deliver. By 2025, transport of biomass will require up to 1.1 billion miles of travel per year by delivery trucks, consuming a cumulative 2 billion gallons of diesel fuel by 2025. Carbon dioxide emissions from use of fuel during transport will be more than 23 million tons by 2025.[15] These numbers do not take into account fossil fuel use during harvest and processing of biomass fuels.

Millions of forest acres would be logged to provide fuel for biomass plants

As the amount of biomass power ramps up, so will forest cutting. The US currently cuts about 2.1 percent of its forests per year, or about 11 million acres. About 39 percent are clear-cut, with all trees removed.[16] EWG estimated the number of additional acres that would need to be logged to meet projected energy demand under two EIA scenarios for biomass buildout and two scenarios for availability of existing biomass fuels.

Figure 3. Forest cutting will increase dramatically under climate bill; clearcut equivalent in acres



Equivalent acres that would need to be cut to meet biomass fuel needs by 2025 under EIA's basic and "no international offsets" scenarios for the House-passed climate bill (American Clean Energy and Security Act).

15 The EIA NEMS model assumes that 50 miles is the maximum distance over which most biomass residues can be transported economically and that the cost of transport within a 50-mile radius is $12/ton. Urban wood waste is assumed to be economically transported over distances of up to 100 miles. (Energy Information Administration, Office of Integrated Analysis and Forecasting. Model documentation: Renewable fuels module of the National Energy Modeling System. DOE/EIA-M069 (2009). July, 2009. Washington, DC.) Our estimate of transport costs also assumed that 50 miles is the maximum distance that biomass would be transported, but this is clearly a dramatic underestimate of even current transport distances, which can be much higher. In addition to domestic transport, the growing international demand for biomass means that wood from the United States is currently being shipped to Europe.

16 Smith, W.B., et al. 2007. Forest Resources of the United States, 2007. United States Forest Service, Gen.Tech Report WO-78. December, 2008.

The acres of cutting that would be required to meet biomass fuel needs are calculated after taking into account "existing" biomass fuel that could be provided by forestry residues, agricultural residues, and urban wood. "High" and "Low" scenarios for availability of these existing fuels were estimated using realistic assumptions as described below.

Harvesting large amounts of forest biomass in a cost-efficient manner requires large, specialized harvesting equipment that swiftly harvests all trees in the target zone. Removal of 50-to-100 percent of trees is typical. We present our results in terms of equivalent wood from clearcutting for the sake of simplicity, since the assumption of removing half the trees for biomass fuel simply requires doubling the number of acres.

For EIA's basic ACESA scenario, assuming *high availability* of existing biomass fuels (crop residues, construction debris, energy crops, and logging residues generated by existing logging operations), about 39 percent of the biomass fuel requirement would have to be met by new forest harvesting by 2025. In this case, cumulative biomass fuel needs by 2025 would require the equivalent of cutting 17.7 million acres. To make up this fuel deficit with energy crops would require harvesting 14.9 million acres of dedicated land each year (see Appendix B for details on how we made these calculations).

Assuming *low availability* of biomass fuel, about 60 percent of the fuel needs would be met by new forest cutting. In this case, biomass fuel needs would require the equivalent of clear-cutting 29.6 million acres by 2025. Meeting this need with energy crops would require 23 million acres to be harvested each year.

III. Why Current Calculations Omit Carbon Dioxide from Biomass Burning

A 2009 paper by Timothy Searchinger et al. in the journal Science called attention to the urgency of fixing a "critical accounting error" that has allowed biomass power to be treated as if it were carbon neutral. The authors concluded that "harvesting existing forests for electricity adds net carbon to the air. That remains true even if limited harvest rates leave the carbon stocks of regrowing forests unchanged, because those stocks would otherwise increase and contribute to the terrestrial carbon sink."[17] The only biomass fuels that do not add net carbon to the air are residues that would otherwise decompose quickly and fuels that result from additional carbon having been previously sequestered beyond what would have been sequestered in the normal course of business.

Forests play an important role in sequestering current carbon emissions from fossil fuel burning. From 2002 to 2007, forests of the continental United States tied up the equivalent of nearly 14 percent of carbon dioxide emissions from the power sector into new above ground growth alone.[18]

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17 Searchinger, T., et al. 2009. Fixing a critical climate accounting error. Science 326: 527 - 5 28.

18 Carbon dioxide sequestered into new forest growth was estimated by calculating the growth increment of forests between 2002 and 2007, using Forest Service data.

Far from providing a carbon neutral fuel source, harvesting standing forests for biomass degrades this critical forest function.

the EPA does not count stack emissions when biomass is burned for power generation, but it also does not account for emissions at the time of harvesting *the result is that emissions from biomass power are never counted*

The "accounting error" that assumes carbon neutrality for biomass power is based on a misreading of internationally accepted carbon accounting standards promulgated by the Intergovernmental Panel on Climate Change (IPCC). These rules count any harvesting of wood as a direct and immediate emission of carbon dioxide to the atmosphere *at the time of harvesting*.[19] These emissions are only considered to be re-sequestered following the slow, often multi-decade regrowth of cut forests. Emissions released when biomass power plants actually burn this fuel are *not* counted under IPCC rules in order to avoid double counting.

The U.S. Environmental Protection Agency (EPA) and other institutions that track carbon emissions have misinterpreted this accounting rule. The EPA does not count stack emissions when biomass is burned for power generation, but it also does not account for emissions at the time of harvesting.[20] *The result is that emissions from biomass power are never counted.*

This feawed accounting system is at the core of US renewable energy policy, including all state and federal renewables portfolios and the House and Senate energy and climate bills.

IV. Current and Proposed Policies Create Powerful Incentives for Tree Cutting

The version of ACESA passed by the House requires large power plants to show emissions reductions (relative to 2005) of 17 percent by 2020, 42 percent by 2030 and 83 percent by 2050.[21] As the electricity generation sector comes under increasing pressure to reduce carbon dioxide emissions, the pressure on forests to provide "carbon neutral" biomass fuel will also increase. Here's why:

Coal-fired power plants are the largest source of electricity generation in the United States, providing more than 50 percent of the national total,[22] and coal is by far the greatest source of carbon dioxide

19 Intergovernmental Panel on Climate Change, 2006. IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry, and Other Land Use. Chapter 4: Forest Lands.

20 Searchinger et al, 2009.

21 Energy Information Administration. Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009. SR/OIAF/2009-05. July 2009. Washington, DC.

22 Testimony of Dr. Richard Newell, Administrator, Energy Information Administration, U.S. Department of Energy, before the Committee on Energy and Natural Resources, United States Senate. October 14, 2009.

from the sector. Because prospects for large-scale carbon capture and sequestration remain a distant illusion, co-firing (replacing some coal with biomass) or "re-powering" (complete conversion to burn only biomass[23]) provide the only real opportunity for the coal power industry to claim it is reducing carbon emissions.[24]

there are also significant financial benefits to replacing coal with biomass

There are also significant financial benefits to replacing coal with biomass. Beyond benefiting from tax incentives and other federal programs designed to promote biomass use, power plants receive renewable energy credits based on the proportion of power they generate using biomass, eliminating the need to buy credits elsewhere. In addition, under regional carbon cap-and-trade schemes such as the Regional Greenhouse Gas Initiative (RGGI) in the Northeast, power plants do not have to purchase emission allowances for the carbon dioxide they emit from burning biomass, an exemption that would also apply at the federal level if a national cap and trade program is enacted. Many coal plants already have the capability to co-fire biomass,[25] and proposals for co-firing and re-powering have increased dramatically.

Trees will be the biomass fuel of choice

There are four primary categories of biomass fuel: "urban wood" (primarily construction and demolition waste, but EIA also includes urban tree trimmings and mill residues); agricultural residues (corn stover, wheat straw, and materials from "a number of other major agricultural crops"[26]); energy crops (such as switchgrass and willows); and forestry residues.

EIA uses price-supply curves to estimate the availability of various biomass fuels. At maximum availability for all categories, EIA estimates that 4.1 percent of the fuel supply would come from urban wood and mill residues, 16.5 percent from agricultural residues, 24.2 percent from forest wood and 55.1 percent from energy crops.

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23 Interestingly, as noted on the website for Mississippi Power, "Re-powering an existing plant typically results in the loss of about 50 percent of the current generating capacity due to the low heating value of biomass compared to natural gas or coal." (http://www.mississippipower.com/topic_renewable/biomass.asp).

24 The idea that biomass co-firing can reduce carbon dioxide emissions at coal plants appears in Congressional testimony from the Acting Administrator of EIA in February 2009. "The impact on carbon dioxide emissions, which are not currently constrained by a cap-and-trade system or otherwise regulated at the Federal level, largely depends on the fuels and generators being displaced -- carbon dioxide reductions are significantly larger when coal is displaced than when natural gas is displaced. Certain renewables, such as biomass co-firing at existing plants, directly displace coal use." (Testimony of Dr. Howard Gruenspecht, Acting Administrator, Energy Information Administration, before the Subcommittee on Energy and Environment, Committee on Energy and Commerce, U.S. House of Representatives, February 26, 2009.)

25 Energy Information Administration, 2009. Form EIA-860 Database: 2007 Annual Electric Generator Report.

26 Energy Information Administration. Model documentation: Renewable fuels module of the National Energy Modeling System. DOE/EIA-M069 (2009), July 2009. Washington, DC. Additional documentation of some of the assumptions behind NEMS modeling is available at http://www.eia.doe.gov/oiaf/aeo/assumption/renewable.html.

EIA assumes no social or environmental constraints on any fuel source, no conflicting demands on resources (such as competition for agricultural residues between biomass power and biofuels production),[27] and the availability of significant amounts of land to grow biomass energy crops as well as the technology and infrastructure to harvest and transport them.

These estimates are significantly too optimistic. Urban wood, consisting primarily of construction and demolition waste, must be sorted to remove pressure-treated lumber and other contaminants, a requirement that raises costs. Mill residues are already allocated to existing uses; only about 1.5 percent of the supply is currently unused and available for power generation.[28] Collection and processing of agricultural residues into forms useable as biomass fuel requires specialized infrastructure that does not currently exist and may not be cost-effective. Additionally, if technology for generating ethanol from cellulosic sources becomes widespread, the nation's ethanol mandate will likely absorb most existing supplies of agricultural residues. Energy crops do not currently exist; to grow the amounts needed for biomass power would require putting millions of acres under cultivation. (Some of these caveats are acknowledged in EIA's documentation: see Appendix B for a detailed explanation of the constraints on fuel availability.)

energy crops do not currently exist; to grow the amounts needed for biomass power would require putting millions of acres under cultivation

The amount of "forestry residues" considered available by EIA is also a large overestimate. EIA's estimate includes "logging residues" as defined by the Forest Service.[29] These are unmarketable low-diameter materials and "cull" (unmarketable) trees cut in the course of harvesting that, if left to decompose, will emit carbon dioxide equivalent to the amount produced by burning them. However, as defined for the EIA biomass modeling inputs dataset,[30] the forest residues category also includes part of the massive national inventory of *standing* cull trees, as well as standing inventories of "excess small pole trees."[31] Because the Forest Service inventory includes standing cull trees on potentially

27 EIA model documentation states that significant uncertainty exists regarding the true availability of agricultural residues, due both to potential competition with the biofuels industry and because the infrastructure for collection and processing of these materials does not currently exist (Energy Information Administration. Model documentation: Renewable fuels module of the National Energy Modeling System. DOE/EIA-M069 (2009), July, 2009.)

28 Smith et al, 2007.

29 The category of logging residues as defined by the Forest Service data includes virtually anything "sound enough to chip" other than the commercial roundwood removed by harvesting. It includes "growing–stock volume cut or knocked down during harvest but left at the harvest site" and "wood volume other than growing stock cut or knocked down during harvest but left on the ground. This volume is net of wet rot or advanced dry rot and excludes old punky logs; consists of material sound enough to chip; includes downed dead and cull trees, tops above the 4–inch growing–stock top, and smaller than 5 inches d.b.h. (diameter at breast height); excludes stumps and limbs." Cull trees are unmarketable because of rot, roughness, or species (Smith et al, 2007).

30 Walsh, M., et al. 2000. Biomass feedstock availability in the United States: 1999 state level analysis. Prepared for EIA; available at http://bioenergy.ornl.gov/resourcedata/index.html

31 The term "excess small pole trees" does not occur in the glossary of terms included with the Forest Service forest

harvestable forest land, whether or not this land is likely to be logged, the estimated supply of potentially harvestable cull and pole trees vastly exceeds the amount of true logging residues that are actually generated each year. [32]

The Energy Information Administration's definition of forestry residues – hidden in plain sight in government documents – is congruent with the wording of ACESA, which defines whole trees, along with logging residues, as "renewable biomass." (see Appendix A for the relevant sections of legislation). It should be emphasized that EIA's expansion of the pool of available "residues" to include standing timber contravenes the standard approach taken in a National Renewable Energy Laboratory report on biomass availability,[33] which excluded increased harvesting of standing timber from the available forest biomass pool.

Because it includes a portion of the standing cull and pole tree inventories, the EIA estimate of potentially available forest wood is about three times greater than the supply of currently generated logging residues alone. Thus, *the majority of forest biomass supply in the EIA model consists of trees that would be cut specifically for power generation*. This will dramatically increase logging above current levels and significantly increase greenhouse gas emissions from the "renewable" power sector. By employing more realistic assumptions about the availability of existing biomass fuels, EWG's analysis determined that even more forest cutting would be required than EIA projects.

The impact of a federal renewable energy standard

To determine how increased deployment of biomass power will increase forest cutting and carbon dioxide emissions, EWG analyzed EIA's scenarios for biomass power development under a federal renewables portfolio standard for electricity. We also examined the impacts of currently proposed biomass power, biofuels and wood pellet facilities.

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inventory dataset but presumably refers to some portion of the standing stock of poletimber, which is defined as "live trees at least 5.0 inches in d.b.h but smaller than sawtimber trees" and which, along with seedling-sapling stands, comprise the "core of the merchantable forests of the mid-21st century" (Smith et al., 2007)

32 Documentation for the ACESA scenarios, available at http://www.eia.doe.gov/oiaf/aeo/assumption/renewable.html, makes it clear that new logging will be required to provide biomass fuel: "Fuel supply schedules are a composite of four fuel types: forestry materials, wood residues, agricultural residues and energy crops. Energy crop data are presented in yearly schedules from 2010 to 2030 in combination with the other material types for each region. The forestry materials component is made up of logging residues, rough rotten salvageable dead wood, and excess small pole trees. The wood residue component consists of primary mill residues, silvicultural trimmings and urban wood such as pallets, construction waste, and demolition debris that are not otherwise used. Agricultural residues are wheat straw, corn stover and a number of other major agricultural crops. Energy crop data are for hybrid poplar, willow, and switchgrass grown on crop land, pasture land, or on Conservation Reserve Program lands."

33 Milbrandt, A. A geographic perspective on the current biomass resource availability in the United States. National Renewable Energy LaboratoryTechnical Report NREL/TP-560-39181. December, 2005. Golden, CO.

EIA modeled total electricity sector development as it would occur under the RPS specified in the House-passed ACESA, which anticipates a significant ramp-up in renewable power generation. EWG analyzed two sets of projections from EIA – one that models the effect of ACESA if enacted as written, and one that achieves the maximum reduction in greenhouse gas emissions by 2025. This is achieved with the assumption that no international carbon sequestration projects will be permitted as "offsets" for domestic emissions, thus forcing greater emissions reductions in the U.S. These reductions would be achieved in part by a substantial increase in biomass co-firing at coal plants, and in the longer term with an 84 percent increase in nuclear power generation by 2025 and a 230 percent increase by 2030 (even under the "basic" case, the EIA projects at 44 percent increase in nuclear power by 2025 and a 91 percent increase by 2030[34]).

EIA's projection include projected impacts of the 2009 American Recovery and Reinvestment Act, as well as other energy laws

EIA measures the potential effects of ACESA against a reference case. Although this "business-as-usual" scenario is EIA's projection of power sector development in the absence of a federal RPS, it does include projected impacts of the 2009 American Recovery and Reinvestment Act (ARRA) as well as other significant energy laws, including the Energy Improvement and Extension Act of 2008, the Energy Independence and Security Act of 2007 and the Energy Policy Act of 2005[35]. All these pieces of legislation promote renewable energy development to some extent.

EIA's estimate of biomass availability already depends on increasing whole-tree harvesting. But EIA appears to dramatically overestimate the availability of other kinds of biomass fuels as well, assuming no social or environmental constraints, no conflicting demands on resources (such as competition for agricultural residues between biomass power and biofuels feedstock)[36] and availability of significant amounts of land to grow biomass energy crops. If these assumptions are incorrect, it is extremely likely that more forests will be cut for biomass fuel than are currently projected, as only forest biomass can fill the gap between projections and reality.

EWG's analysis introduced constraints on EIA's assumptions about biomass availability, describing a likely range for each fuel category by specifying a "high" and "low" availability factor that modifies the amount of biomass in the basic dataset. We then estimated what these constraints would mean for the demand for forest wood to serve as biomass fuel (where availability of biomass is low, demand for new forest cutting will be high). Our assumptions were as follows (for a detailed explanation of how we arrived at these values, see Appendix B):

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34 Projections from EIA's AEO2009 National Energy Modeling System run hr2454noint.d072909 and AEO2009 National Energy Modeling System run hr2454cap.d072909a.

35 Testimony of Dr. Richard Newell, Administrator, Energy Information Administration, U.S. Department of Energy, before the Committee on Energy and Natural Resources, United States Senate. October 14, 2009.

36 EIA model documentation states that significant uncertainty exists regarding the true availability of agricultural residues, due both to potential competition with the biofuels industry, and also because the infrastructure for collection and processing of these materials does not currently exist (Energy Information Administration. Model documentation: Renewable fuels module of the National Energy Modeling System. DOE/EIA-M069 (2009), July, 2009.)

Table 1. Non-tree Biomass Supplies Are Limited

Biomass is sought for other uses. Percentage of each source available as fuel for power plants is shown for two scenarios, assuming either high or low availability.

	Low availability	High availability
Urban wood	25%	75%
Mill waste	42%	42%
Agricultural residues	25%	50%
Logging residues	24%	24%

Percentage of EIA's estimates of existing wood and agricultural residues that the EWG re-analysis assumes are actually available. The estimate of logging residue availability is based on the Forest Service estimate of currently generated logging residues, and not EIA's estimate, which includes whole-tree harvesting along with currently generated residues. Under a "high availability" scenario, there is less need for additional forest cutting to meet fuel needs. Bracketing the extremes of low and high fuel availability defines the limits to EWG's estimates (see Appendix B for details).

For its analysis, EIA combined logging residues and increased whole-tree harvesting of cull trees and "excess pole trees" into a single estimate of forest biomass availability. In order to determine the amount of whole-tree harvesting that would be required above current cutting levels, EWG assumed that the forest wood category includes just true logging residues as defined by the Forest Service – that is, the amount of low diameter material and unmarketable trees currently cut each year. This allowed us to calculate the size of the fuel deficit that would be met by increased whole-tree harvesting.

Our approach assumes that currently generated logging residues are the only source of forestry wood that can be used for biomass fuel without significantly increasing carbon dioxide emissions, because their use does not generate greenhouse gas emissions beyond what would be generated if these materials were left to decompose on the forest floor. However, we do not assume that logging residues are "carbon neutral" in any meaningful sense, since burning them emits an instantaneous pulse of carbon dioxide, while natural decomposition would occur over a matter of years while maintaining soil nutrient status and building soil carbon.[37]

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37 Advocates of using logging residues for biomass fuel sometimes claim that allowing logging residues to decompose in the forest actually produces more greenhouse gas emissions than collecting and burning them, because decomposition can involve bacterial methane production, and methane is a more powerful greenhouse gas than carbon dioxide. To the extent that this occurs, however, the phenomenon has likely been significantly overstated. In fact, bacterial methane production during decomposition occurs under low oxygen conditions that occur mostly in wetland soils, and not in the well-aerated conditions of uplands where most logging residues are found. Additionally, another group of bacteria consumes methane produced in forest soils, so that some soils actually act as net sinks for methane, consuming more than is produced locally. Bacterial methane production in upland environments is not even considered important enough to be included in EPA's listing of methane sources (http://epa.gov/methane/sources.html), which focuses on methane production in wetlands. Methane production from termites can occur in upland areas, but again, bacterial consumption of methane also occurs. In all, net methane flux to the atmosphere from decomposition of logging residues is poorly characterized, and the "methane myth" that decomposition of forest residues emits more greenhouse gases than combustion of those residues is not backed up by credible science.

Because every state with a renewable electricity mandate includes biomass power as an eligible technology, and many incentives for biomass power development already exist, biopower proposals have already increased dramatically. To assess the emerging demand for wood fuel at bioenergy facilities, EWG used commercially available data to analyze current proposals for biomass power, wood pellet and liquid biofuels plants that plan to use wood as feedstock.

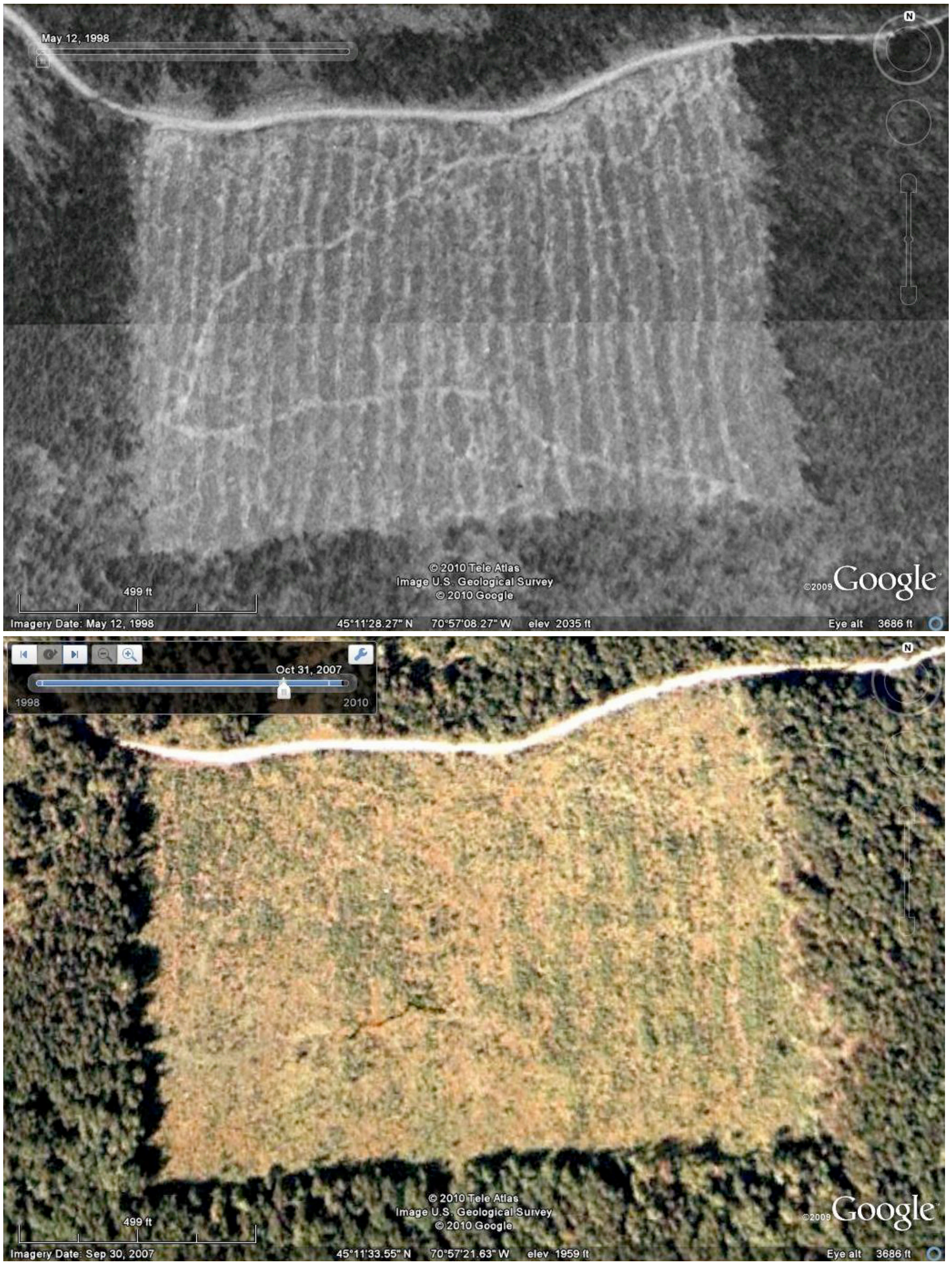
V. Why Burning Trees is Worse than Burning Coal

Unfortunately, cutting and burning trees for power actually emits *more* carbon than burning fossil fuels per unit of energy generated. Because wood and other biomass materials have a very low energy density, and because biomass power plants are significantly less efficient than gas and even coal plants, carbon dioxide emissions from biomass per unit of energy generated are about 1.5 times higher than from coal and three to four times greater than from natural gas.

Biomass plants are extremely inefficient. Large-scale biomass power plants typically operate at less than 25 percent efficiency, meaning that for every four tons of wood burned, one ton is converted into electric power -- but all four tons emit carbon dioxide. The more forest biomass is used to replace fossil fuels, the more greenhouse gas emissions will increase.

Cutting forests to burn trees in power plants is actually a global warming double whammy. An intact forest sequesters atmospheric carbon dioxide into new growth each year. Following logging, it takes decades to rebuild the lost biomass. This results in a net increase in atmospheric carbon dioxide levels, just as biomass burning does. The double impact of wood burning for energy, both from smokestack emissions and reduction of the forest carbon "sink" for atmospheric carbon, is occurring just when reducing carbon emissions is most urgent.

Figure 4: Forest regrowth takes decades



Satellite images of Maine's Boundary Mountains region show that in this tract, logged sometime before 1998, trees had not yet returned after 10 years to take up carbon released by logging. According to Forest Service data (Smith et al, 2007), the trees from this 25-acre clear-cut would be sufficient to fuel one 50 megawatt biomass plant for only about 21 hours. Source: Google Earth images, 1998 and 2007.

VI. Demand for Bioenergy Will Put More Pressure on Forests

A surge in proposals for biomass power, wood pellet and biofuels plants that use wood for feedstock is already underway in the United States, spurred by state renewable electricity standards and existing federal tax policies even in the absence of a federal renewables standard or climate legislation. At least 118 new wood-burning facilities[38] and biomass co-firing operations are currently proposed, representing about 5,830 MW of capacity.[39] Total proposed capacity is thus almost double existing capacity.[40] The average size of proposed direct-fired biomass plants is 39 MW, about a third larger than the average capacity of existing plants. Total wood demand for this amount of biopower will be about 71 million green tons per year.

The market for wood pellets is also expanding dramatically, both domestically, where use is primarily in the residential heating market, and internationally, where biomass is in demand for power generation.[41] About 60 new wood pellet plants are currently proposed or under construction in the United States, with a combined wood demand of about 21 million green tons per year.[42] Wood pellets are mostly produced from mill residues or whole-tree harvesting, not logging residues.[43] Some coal plants that are proposing to co-fire biomass have found that in order to meet emissions requirements, they can only burn pellets or chips made with white, interior bolewood of trees that does not include any bark or low-diameter material.[44]

Due to their composition and cost of production, wood pellets typically sell for around ten times the cost of unprocessed woodchips.[45] Nonetheless, international demand is exploding. In Great Britain alone, proposals for 3,070 MW in direct-fired biomass projects represent an order of magnitude increase over current generation, a figure that does not include power generated from biomass co-

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38 Development costs for proposed direct-fired plants will total about $12.5 billion.

39 Some biomass co-firing proposals do not yet specify the percentage coal that will be replaced. We estimated 10 percent co-firing in these cases.

40 As of 2008, there were 151 operating facilities representing 2,910 MW of biomass power in the United States whose primary fuel is "wood solids," and another 153 facilities, representing 4,263 MW, where wood liquors from pulp and paper manufacturing are the primary fuel. Of these, 80 facilities, representing 2,305 MW of generation, use wood solids as a secondary fuel. (Energy Information Administration. Existing electric generating units by energy source, 2008)

41 Under a European Union directive that member states must generate 20 percent of their electricity from renewable sources by 2020, Great Britain and Europe plan a massive ramp-up of biomass power.

42 RISI Wood Products Database, 2010.

43 Many pellet companies utilize only stemwood for pellets, finding that bark and residue material produce too much ash when pellets are combusted. (Grard, L.. Pellet-producing plants going strong. *Kennebec Journal*, November 1, 2009.)

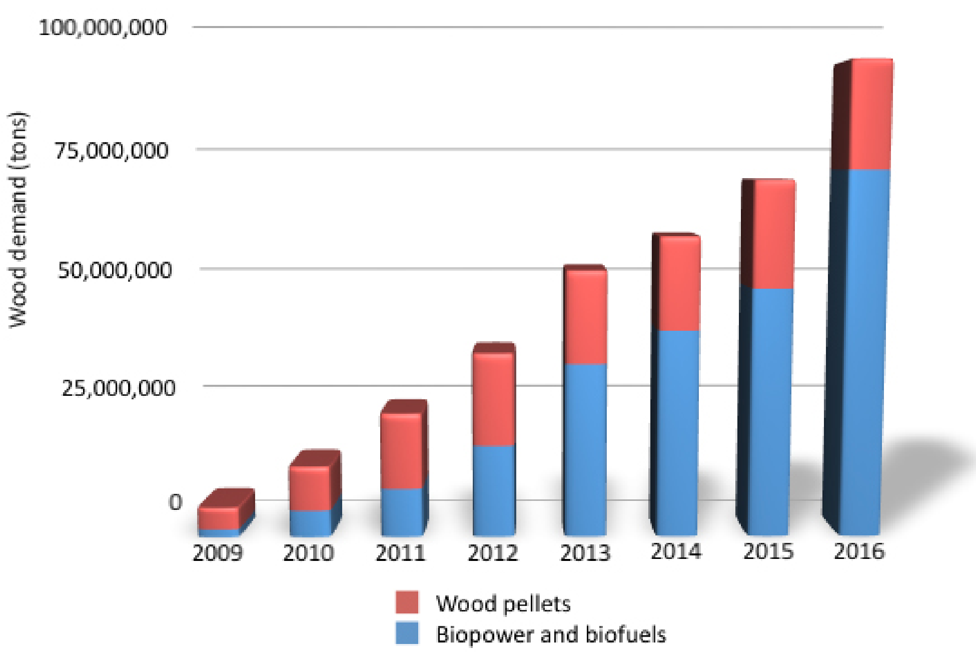
44 Notes from Ohio Solid Biomass Work Group meeting, March 12, 2010. Representatives of First Energy, which owns the Burger coal plant, stated that burning significant amounts of agricultural residues or any wood other than white interior wood would make it difficult to meet emissions requirements.

45 http://www.woodpelletprice.com

firing. Most new biomass plants will be located near deep-water ports that can accommodate marine shipments of fuel from remote locations. Green Circle Energy of Georgia, which at a production capacity of 560,000 tons per year is the largest pellet plant in the nation, ships exclusively to Europe.

Proposals for biofuels plants will also place new demands on forests. Currently, there are eight plants proposed in the United States that would use wood for feedstock, with a combined wood demand of about 3.6 million tons, but the projected demand for cellulosic biofuels feedstock is increasing. The total projected wood demand for biopower, pellet, and biofuels proposals is about 92 million green tons.

Figure 5. Wood demand for projects in the pipeline is already increasing



Cumulative wood demand for proposed biomass power, biofuels and wood pellet projects. Projects without firm start dates were classified as starting in 2015 and 2016 for purposes of this illustration. To the extent that biopower facilities use wood pellets from new capacity, demand projections may be overstated. However, the international market and the residential and commercial heating markets for pellets are also expanding rapidly. (Source: RISI Wood Products database; EWG research).

VII. Biomass Power Development Will Cost Taxpayers Billions of Dollars

Biomass power is eligible for tax credits and direct subsidies from the federal government.[46] Currently, the federal renewable energy production tax credit (PTC) for biomass power[47] is set at 1.1 cents per kilowatt-hour, a rate that reduces the tax burden of a typical 50 MW plant by about $4.4 million,[48] or about $96,360 for every megawatt of biomass at a coal plant or a direct-fired plant. Facilities can receive the PTC for a period of five years.[49] The Congressional Budget Office estimated that lost tax revenues from the biomass PTC at $1.5 billion for 2009 – 2013 under a business-as-usual scenario; if biomass power development accelerated as envisioned by EIA's ACESA scenario, the total cost of the biomass PTC over the next five years would be about $3.5 billion, and about $10.5 billion over the next fifteen years.

Instead of taking the production tax credit, biomass developers can elect to take an investment tax credit created under the 2009 American Reinvestment and Recovery Act (ARRA), which reimburses 30 percent of plant development costs if the plant begins operation within a certain period. Many of the plants currently proposed are eager to begin construction as soon as possible to qualify within the eligibility window for this program, which will yield a $30 million to $75 million savings for a typical utility-scale biomass plant.[50]

Besides avoiding tax payments, direct-fired and co-fired biomass plants also avoid the expense of purchasing carbon emission allowances. Existing cap-and-trade schemes such as the Regional Greenhouse Gas Initiative (RGGI) in the Northeast and the proposed federal cap-and-trade program require facilities to pay for every ton of carbon dioxide they emit, funds that are returned to the states under the regional programs to support energy efficiency and renewable power initiatives. Biomass emissions are exempted from regulation due to the assumption of carbon neutrality, resulting in substantial savings to the industry; for instance, a typical 50 MW biomass power plant would avoid payments of $58 million over the initial five-year period of a federal carbon pricing scheme starting in 2012, a savings that would increase to $110 million for the 2021 – 2025 period.[51]

besides avoiding tax payments, direct-fired and co-fired biomass plants also avoid the expense of purchasing carbon emission allowances

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46 The incentives for biomass power development at the state level are too numerous to mention in this report, but the DSIRE database (http://www.dsireusa.org/) provides a comprehensive listing.

47 Rate for open-loop biomass

48 Kotrba, R. The Power of Association. *Biomass Magazine*, June, 2008.

49 The biomass industry is currently lobbying to have this period extended.

50 Our survey of plants under development determined that typical development costs for utility-scale plants are $100 million to $250 million, although some proposals are significantly higher.

51 EIA includes carbon allowance pricing in its modeled projections. Under the basic scenario, of the allowance price

Regulating biomass emissions would increase cumulative covered emissions by up to 17 percent by 2025 and would represent a staggering $129 billion in carbon allowance value, although the total would be somewhat smaller to the extent that emissions from some plants are probably lower than EPA's proposed threshold value for regulation and thus would not be covered under the cap.[52] Allowance payments from biomass facilities could potentially be refunded to the extent that facilities were able to demonstrate that they were not adding net carbon to the atmosphere. Currently, funds from purchase of allowances under regional cap and trade programs like RGGI are returned to the states, and the revenue lost by not regulating biomass emissions is an increasing proportion of total potential revenues.

biomass power facilities and fuel suppliers also benefit from direct payments

Biomass power facilities and fuel suppliers also benefit from direct payments. Facilities burning biomass can generate Renewable Energy Credits (RECs),[53] selling them or using them to meet their own renewable power purchase requirements. At recent REC prices, which have been volatile, a typical 50 MW plant generates about $3 million to $20 million in credits per year. Assuming a rate of $0.05 per kWh, facilities burning biomass would receive about $47.2 billion in revenue from RECs from 2014 – 2018 under the basic ACESA scenario.

Biomass suppliers are also eligible for the Biomass Crop Assistance Program, a federal program administered by the U.S. Department of Agriculture that matches what facilities pay for fuel, paying suppliers up to $45 per dry ton (about $25 per green ton). The program has been extremely popular; $517 million of taxpayer money was allocated for the first quarter of 2010.[54]

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for a ton of carbon dioxide will rise from $16 in 2012 to $41 in 2025. Projections from EIA's AEO2009 National Energy Modeling System run hr2454cap.d072909a.

52 EPA's proposed rules for carbon regulation would exempt new facilities emitting less than 100,000 tons of carbon a year.

53 Purchase of Renewable Energy Credits or Certificates (RECs) from renewable power producers allows buyers to claim avoidance of the environmental impacts of their electricity, since the REC represents a specific amount of avoided greenhouse gas emissions. The price of RECs is partially tied to the difference between the cost of production at a renewable energy facility and the price offered for power sold to the grid. The RECs can be sold separately from the power itself, which is fed into the grid and becomes indistinguishable from power generated from conventional sources. RECs thus essentially serve as a demonstration that a certain amount of power has been generated from renewable sources. Every megawatt-hour of electricity generated from a renewable source is assigned a REC with a tracking number, allowing transfers between buyers and sellers to be monitored. Once a final owner makes a claim, the REC is retired. Regional tracking systems across the United States allow RECs generated in one part of the country to be purchased in another.

54 Wood Resources International LLC. Forest products market update, January 2010. www.woodprices.com.

VIII. State Policies are Creating Biomass Power Hotspots

Biomass power development at the state level is not waiting for a federal renewables portfolio standard. Currently, 37 states and the District of Columbia have some form of Renewable Electricity Standard or renewable generation goal,[55] and all include biomass as an eligible technology. In 2007, 45 states in the continental United States generated some power from renewable sources (including wood and wood-derived fuels,[56] wind, solar and geothermal). Of these, 24 depended on wood and wood-derived power to provide at least 50 percent of that renewable power.[57] What follows is a closer look at five forested states where biomass power is at various stages of development. Given the "substantial and sustained net loss of forest cover"[58] that has occurred in eastern forests over the last three decades, further forest loss should be taken very seriously.

Maine – furthest down the biopower road

Biomass power is already a major component of Maine's electricity supply, providing about 24 percent of the state's power in 2007[59], a pace well ahead of EIA's modeling estimate that approximately 16 percent of Maine's power would come from biomass by 2030.[60] This commitment has profound implications for Maine's greenhouse gas emissions.

On paper, greenhouse gas emissions from Maine's electricity generation sector[61] are relatively low, for several reasons: Emissions from biomass burning are not counted, and the state generates about 23 percent of its electricity from hydropower, which has no stack emissions. Maine gets another 41 percent of its power from natural gas, which has the lowest emissions per unit energy of any fossil fuel. Maine's total reported emissions from power generation were 5.57 million tons of carbon dioxide in 2007.[62]

But these figures are misleading. If stack emissions from biomass power generation were counted, it would more than double total emissions from the power sector, contributing an additional 7.9

55 Database of State Incentives for Renewables and Efficiency; http://www.dsireusa.org

56 Includes "wood liquors" used as fuel, by-products of the paper and pulp industry

57 Energy Information Administration. 1990 – 2008 Net generation by state by type of producer by energy source (EIA 906) (available at http://www.eia.doe.gov/cneaf/electricity/page/capacity/capacity.html).

58 Drummond, M. and Loveland, T. 2010. Land-use pressure and a transition to forest-cover loss in the Eastern United States. Bioscience 60:286-298.

59 Ibid. For 2007, Maine had about 615 MW of biomass power operating, which provided 3.85 billion kWhrs of electricity.

60 This goal is approximate, and is based on EIA's modeling for the New England region, in which Maine is located.

61 Energy Information Administration. 1990 – 2008 U.S. electric power industry estimated emissions by state (EIA-767 and EIA-906).

62 Ibid.

million tons of carbon dioxide each year.[63] Total lifecycle emissions, including the reduced carbon sequestration capacity of logged forests, would be even higher.

if stack emissions from biomass power generation were counted, it would more than double total emissions from the power sector

Maine's commitment to wood-fueled power is not surprising, given the importance of the forest products industry to the state. Some basic math shows that even in Maine, the biomass power industry does not run just on logging residues but relies also on whole tree fuel. Shortages of wood and favorable economics have also led the state to permit importation and burning of construction and demolition waste from other states. Neither whole tree fuel or construction and demolition waste can be considered carbon neutral.

The amount of mill residues and logging residues generated in Maine in 2006 was almost exactly equal to the total amount of wood from all sources burned in biomass plants in 2007, meaning that it would take 100 percent utilization of all potentially available of sources of residues to provide the biomass fuel needed in the state. But 100 percent utilization is impossible, since mill residues have greater economic value and are used in other applications,[64] and logging residues are not completely collectable. The shortage has to be made up with whole tree fuel.

Evidence on the ground supports this conclusion. As is the case for the proposed federal energy legislation (see Appendix A), Maine does not distinguish between biomass fuel from logging residues and whole tree fuel. The state's forest cutting practices allow clear cuts of up to 250 acres for "forest products," the definition of which includes biomass fuel.[65] The result is not only whole-tree but also "whole forest" removal, with the biomass industry providing a market for as much material as can be removed from a site. Cutting is also increasing to provide material to the state's growing wood pellet industry, which currently supplies the domestic home heating market and is growing, partially in response to increasing European demand.[66] Current and proposed pellet mills in the state will require at least 840,000 green tons by the end of 2010.[67]

As recently as 2002, Maine was cutting about 10 percent more timber than it was growing, and

63 We took the total number of MWhrs reported by EIA as having been generated from woody fuels in Maine in 2007, and converted this to fuel use by assuming 8600 BTU/lb wood (bone dry; EIA's estimate). We assumed wood is 50 percent carbon.

64 Canfield, C. Mill, Waste No Longer Just Dust in the Wind. Associated Press, April 3, 2008. This article reports that the price of sawdust to dairy farmers who use it as bedding had gone from $800 to upwards of $1400 for a trailer load between 2007 and 2008.

65 Maine Department of Conservation. 1999. Forest regeneration and clearcutting standards. Available at http://www.maine.gov/doc/mfs/pubs/htm/fpafnl.htm#SECTION 5.

66 Spelter, H. and Toth, D. 2009. North America's wood pellet sector. United States Forest Service Forest Products Laboratory, FPL-RP-656.

67 RISI Wood Products Database, 2010.

removals plus mortality were 165 percent of net growth,[68] meaning the state's forests as a whole were serving as a net carbon source, not a carbon sink. As of the 2007 forest inventory, cutting had slowed somewhat but removals were still 84 percent of net growth, and removals plus mortality were 130 percent of net growth.[69] Increasing demand for bioenergy wood may drive Maine forests even further into the red.

Figure 6. Clear-cutting for biomass energy in Maine

Biomass clear-cut in the Moosehead Lake region, Maine, 2009. (credit. James Wallace)

Massachusetts – thinking twice about biopower

With only one utility-scale (17 MW) biomass plant, as well as a few small plants primarily operated for thermal power, Massachusetts has not been a hotspot of biopower until recently. However, the simultaneous consideration of four large-scale wood-powered projects – two biomass plants that would burn forest wood, one that would burn about 80 percent construction and demolition debris, and a proposal to repower the 120 MW Somerset coal plant with construction and demolition debris – caught the attention of citizens concerned about forest cutting, carbon emissions and air pollution.

68 Smith et al, 2007.
69 Ibid.

The combined generation of the four proposals would be 255 MW, or about 1.9 percent of the state's total generating capacity. Excluding the power that would be generated by burning construction and demolition waste, the amount of power to be fueled by forest biomass would be about 105 MW.

Only about 106,000 tons of total forest residues were generated in the state in 2007, enough to fuel about 8 MW of biomass power, so additional biomass to fuel these plants would likely come from increased forest cutting. Expert testimony submitted to the state suggested that fuel demand from these large plants would require the equivalent of heavily logging every eligible forest acre in the state within less than 20 years, and that fuel demand from even one of the plants would require doubling the rate of forest cutting in the state.

fuel demand from these large plants would require the equivalent of heavily logging every eligible forest acre in the state within less than 20 years

In response to objections from citizens and environmental groups, the state commissioned a sustainability study of biomass power and suspended biomass' eligibility for the state's Renewables Portfolio Standard pending its completion.

Massachusetts also provides insight into the limitations of burning so-called urban wood (primarily construction and demolition waste) for power generation. In 2009, citizens protested potential pollutant emissions from burning construction and demolition debris at a plant proposed in the city of Springfield, which has environmental justice[70] concerns over high asthma levels and high incidence of elevated blood lead levels in children.[71]

In response to objections raised by environmental groups, citizens and the Massachusetts Bureau of Environmental Health, the state suspended permitting of facilities that would burn construction and demolition debris pending completion of a statewide environmental and health impacts study. Lending its voice to the issue, the Massachusetts Medical Society passed a resolution opposing large-scale biomass plants on the grounds that they would increase air pollution[72] and present an unacceptable risk to public health.

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70 Lower-income and minority communities suffer from a disproportionately high share of environmental burdens and at the same time lack environmental assets in their neighborhoods. The State of Massachusetts defines an environmental justice community as a neighborhood where median annual household income is at or below 65% of the statewide median income; 25% or more of the residents are a minority; 25% or more of the residents are foreign born; or 25% or more of the residents are lacking English language proficiency. http://www.mass.gov/envir/smart_growth_toolkit/pages/mod-ej.html

71 Letter from Suzanne Condon, Director, Massachusetts Bureau of Environmental Health, to Daniel Hall, Executive Office of Energy and Environmental Affairs, November 19, 2009.

72 Massachusetts Medical Society adopts policy opposing biomass power plants. Press release, Massachusetts Medical Society, December 9, 2009.

Florida and Georgia – headlong into biopower

Florida and Georgia are in the heart of the Southeastern wood products industry and are home to a number of existing biopower facilities that utilize byproducts of pulp and papermaking to generate heat and power. Both states are also seeing a dramatic increase in proposals for utility-scale biomass power plants and wood pellet plants.

Table 2. Proposed biomass power plants and pellet plants, Florida and Georgia

	Florida	Georgia
Existing biopower[73] (MW)	382	643
Biopower proposals (number of facilities)	9	14
Biopower proposals (MW)	679	846
Wood demand, new biopower (million green tons)	8.2	10.3
New pellet plant proposals, number of facilities	1	7
Pellet plant wood demand (million green tons)	1.1	6.6
Total new wood demand (million green tons)	9.4	15.4
Available logging residues (million green tons)	2.7	7.5

The biomass industry is fully aware that the amount of wood currently being cut is not sufficient to provide fuel for all the proposed biomass plants. In August 2009, Biomass Magazine reported that, "Hardly a day passes in the Southern U.S. without an announcement of a new bioenergy facility or expansion of an existing one… What is increasingly obvious is that the amount of truly available logging residues will be nowhere near enough to supply the current and announced bioenergy processors in the Southern U.S… The increasing scale of forestry biomass for bioenergy will only be possible with developments in forest bioenergy plantations as there will be insufficient feedstock from logging residuals for all announced and planned facilities."[74]

the minimum time for resequestration of the carbon released by burning trees for power is more than 25 years

More than 34 percent of Florida's forests and 30 percent of Georgia's forests already consist of intensively managed plantations.[75] Creation of new "energy wood" plantations will likely further reduce native forests, as the amount of agricultural land available for afforestation is increasingly limited, and a more lucrative market for energy crops grown on agricultural lands is emerging.

73 According to EIA data, the large majority of existing biopower facilities in Georgia and Florida use wood liquors as their primary fuel, not wood solids.
74 Gonzales, R., et al. Filling a Need: Forest Plantations for Bioenergy in the Southern US. *Biomass Magazine*. August 2009.
75 Smith et al, 2007.

Wood from even fast-growing plantations cannot be considered a low carbon fuel. Typical Southern pine plantations are usually thinned at 15 years and are harvested completely at around 25 years.[76] Even under such tight harvest cycles, the minimum time for resequestration of the carbon released by burning trees for power is thus more than 25 years,[77] not even accounting for the loss in overall carbon storage involved in conversion of native forests to pine plantations, which can be significant.[78] The proposed increase in biomass power in the Southeast will therefore represent a significant increase in carbon emissions.

Ohio – using biopower to consolidate a commitment to coal

despite claims that various fuels could be employed, including agricultural residues, it is clear that wood will constitute the lion's share

Ohio generates more than 85 percent of its electric power from coal and has more coal-fired generation any state but Texas.[79] It also has the second highest power sector greenhouse gas emissions. To help meet an ambitious goal of producing 25 percent of its power from renewable resources by 2025, Ohio is choosing to co-fire biomass at coal plants. The state has created further incentives for co-firing by granting extra renewable energy credits for power generated at facilities above 75 MW that "primarily" use biomass.[80]

Ohio's Public Utilities Commission is currently considering proposals for renewable energy certification from seven coal plants that plan to co-fire biomass at varying percentages, as well as from one direct-fired biomass plant. Depending on the percentage of co-firing, the proposals would provide up to 1,318MW of biomass capacity. Despite claims that various fuels could be employed, including agricultural residues, it is clear that wood will constitute the lion's share, with potentially massive effects on the state's forests. Even taking into account the somewhat greater efficiency of coal plants than direct-fired biomass plants,[81] the combined demand by these facilities for wood would be more than seven times the total amount of logging residues currently generated in Ohio, about 1.8 million green tons per year.[82] Use of wood pellets would increase wood demand further,

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76 Gonzales et al, 2009.

77 The totality of lifecycle emissions of fuel from forest plantations is significantly higher than just emissions from burning, because these tree "crops" require intensive management and chemical inputs.

78 Replacement of native forests by plantations represents a substantial reduction in the amount of carbon held in forest biomass, as dense long-lived hardwoods are replaced by fast-growing softwoods. Sohngen, B., and Brown, S. 2005. The influence of conversion of forest types on carbon sequestration and other ecosystem services in the South Central United States. Ecological Economics 57:698-708.

79 Energy Information Administration.. 1990 – 2008 Net generation by state by type of producer by energy source (EIA 906) (available at http://www.eia.doe.gov/cneaf/electricity/page/capacity/capacity.html).

80 This provision is interpreted by the utilities to mean that at least 51 percent of power must be fueled by biomass.

81 EIA assumes coal plants have efficiencies around 35 percent; direct-fired biomass plants have efficiencies around 20 – 24 percent.

82 Smith et al, 2007.

since their production requires about two tons of wood to produce one ton of pellets. Where torrefaction (pre-combusting fuel to improve its usability) is used, the impacts of fuel preparation on wood demand and greenhouse gas emissions are even higher.

Utilities and other biomass developers in Ohio have been vague regarding their fuel sources, admitting that they do not know what the final mix will be. The proposed 200 MW South Point biomass plant says that about 45 percent of its fuel supply of about 2.4 million green tons a year will come from utility right-of-way clearing, but that it will need contracts with 30-to-40 contractors to provide the rest. Some will come from land clearing for coal mine expansion. In its application to the Public Utilities Commission, the coal-fired Conesville Generating Station wrote that it will use "solid biomass fuel, including but not limited to torrefied biomass, raw wood chips, sawdust, wood pellets, herbaceous crops, agricultural waste [that] will be co-fired with coal and/or natural gas in proportions up to 100% of total heat input."[83]

The 1,125MW Beckjord plant, which plans to co-fire up to 100 percent with biomass, says that, "the most likely initial fuel will be woody biomass produced by whole tree chipping" from a 50-mile radius of a coal-loading terminal on the Big Sandy River. The 350 MW Burger coal plant in Shadyside, Ohio, proposes to co-fire 60 percent or more of its capacity with biomass. However, in a March 2010 meeting on biomass fuel availability,[84] an official from the plant admitted that to meet emissions requirements, only white interior wood can be used, with no limbs, bark or leaves, and that due to emissions and fuel feeding considerations, the plant would only be able to supply 10–to-20 percent of its biomass fuel with agricultural residues. The inescapable conclusion of these restrictions is that the three million tons of biomass required by the Burger plant would mostly come from whole-tree harvesting.

Several groups[85] have filed motions with the Public Utilities Commission of Ohio to intervene in proceedings that would grant "renewable energy" status to these facilities, expressing concerns about the viability of the fuel supply and impacts on forests. The Ohio Consumers' Council, which has intervened on all co-firing applications, said of the Beckjord plant:

"In order to replace the coal with biomass for up to 100% of the total heat supplied, the Applicant will need a massive amount of biomass material. The Applicant does not identify its source of

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83 The application goes on to explain that the torrefaction process, which partially pre-combusts woody biomass, "decreases the amount of moisture and volatile matter in the fuel. Raw or green biomass is more volatile than coal and its dust. Because of this, there is a risk of explosion given ignition source. If raw or green biomass is integrated into the fuel supply, significant investment in materials handling and fire protection and detection would be required." (Application for certification as an eligible Ohio renewable energy resource generating facility from the Southern Company for Conesville Generating Station Unit 3, to the Public Utilities Commission of Ohio)

84 Buckeye Forest Council, Ohio Solid Biomass Work Group Meeting notes, March 12, 2010.

85 These include the Ohio Consumers Council, the Ohio Chapter of the Sierra Club, the American Wind Energy Association, Ohio Advanced Energy, the Environmental Law and Policy Center, and the Buckeye Forest Council.

biomass material. If the Commission grants this Applicant a certificate for a renewable source, the Applicant may commence with costly modifications on the six generating units identified in its application. If the Applicant is unable to obtain the huge supply of biomass materials it claims it will employ to produce power in these plants, any potential retrofits will not provide the benefits intended and consumers should not bear costs associated with these potential retrofits or modifications. In order to prevent such a wasteful project, the Applicant should be required to identify its source of biomass materials before receiving certification."[86]

IX: Conclusion and Recommendations

Biomass power is at the core of federal and state renewables portfolio standards and congressional climate change legislation and is expected to deliver the lion's share of "renewable" power in the United States over the next 15 years. Unless bogus carbon accounting schemes are reformed, this headlong rush to biomass fuels will produce several perverse and potentially devastating outcomes that are currently being overlooked by the Congress, the EPA and state policy makers.

Cutting of US forests will sharply increase, and when this wood is burned in power plants, it will produce a huge surge in carbon emissions that will be kept off the books and, even worse, will be counted as an emissions reduction. As a result we will seriously erode the power of standing forests to pull carbon out of the atmosphere, allow coal plants to continue operating by co-firing and fuel-switching, and stymie real progress toward true alternative power sources.

This unacceptable outcome results from the glaring but largely unrecognized flaw in carbon accounting practices, which falsely assume that burning biomass fuels, including trees, produces zero net carbon emissions.

The biomass industry has no shortage of talking points contending that logging improves forest health and that "sustainable" harvesting can provide a carbon-neutral fuel source. But no argument can avoid the fact that burning forests for energy transfers carbon stocks from standing forest into the atmosphere and degrades the forest carbon sink. Despite this, billions of dollars in subsidies and tax breaks, as well as and higher electricity rates for consumers who pay extra to purchase "green" energy, are creating powerful incentives for biomass power generation. And although the assumption of carbon neutrality for biomass energy lies at the heart of every state and federal incentive, neither EPA nor any other agency has critically examined this concept, even though lifecycle greenhouse gas analysis is now mandated by law for biofuels.

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86 Motion to intervene and comments by the Office of the Ohio Consumers' Counsel. In the matter of the application of Duke Energy Ohio – Walter C. Beckjord Generating Station for certification as an eligible Ohio renewable resource generating facility. Case No. 09-1023-EL-REN, Public Utilities Commission of Ohio.

Environmental Working Group recommends:

Pass a strong climate bill.

Congress must enact strong climate legislation that eliminates the biomass carbon accounting loophole. Carbon accounting practices must be corrected to include the full and immediate impact of cutting down forests to burn in biomass power plants. Biomass burning must not be permitted unless each specific proposal can unequivocally demonstrate that it will not increase greenhouse gas emissions, even in the short term. These reforms must be incorporated into all federal and state energy and climate policies.

Require biomass power plants to purchase emission allowances.

Biomass plants should be added to the list of "covered entities" required to purchase carbon emission allowances under federal and regional cap-and-trade programs. To the extent that biomass emissions are demonstrably re-sequestered in a short period of time, exceptions could be made.

Eliminate federal and state incentives for biomass power.

The federal production tax credit for biomass systems that burn whole trees, meaning chipped or pelletized whole trees, must be eliminated. This provides a massive federal subsidy for forest exploitation. Likewise, the Biomass Crop Assistance Program (BCAP) program providing matching funds to biomass suppliers should be revised to exclude funding of any facilities or operations that encourage forest cutting.

Exclude utility-scale biomass and co-fired coal plants from renewables portfolio standards.

Only high efficiency, small-scale, combined heat-and-power plants that extract maximum energy value from "additional" biomass should be considered to sell Renewable Energy Credits, and such projects should also undergo rigorous lifecycle analysis to determine their carbon footprints. "Additional" biomass should be defined as sustainably generated biomass containing carbon that would not otherwise remain stored, or become stored, or be meaningfully used for purposes other than energy production.

Appendix A: Biomass provisions in proposed climate and energy legislation

Biomass provisions in the House-passed ACESA and other federal legislation place few restrictions on forest cutting for biomass fuel. In ACESA, the definition of "renewable fuel" at Title I, Sec. 101(a)(16)(H)(ii) includes:

- Trees, logging residue, thinnings, cull trees, pulpwood, and brush removed from naturally re-generated forests or other non-plantation forests
- Dead or severely damaged trees removed within 5 years of fire, blowdown, or other natural disaster, and badly infested trees.
- Materials, pre-commercial thinnings, or removed invasive species from National Forest System land and public lands… and that are –

    (i) not from components of the National Wilderness Preservation System, Wilderness Study Areas, Inventoried Roadless Areas, old growth or mature forest stands, components of the National Landscape Conservation System, National Monuments, National Conservation Areas, Designated Primitive Areas; or Wild and Scenic Rivers corridors;
    (ii) harvested in environmentally sustainable quantities, as determined by the appropriate Federal land manager; and
    (iii) are harvested in accordance with federal and state law, and applicable land management plans.

The American Power Act, as proposed in the Senate, contains a definition of renewable biomass to be inserted in the Clean Air Act, which includes:

- "Materials, pre-commercial thinnings, or removed invasive species from National Forest System land and public lands …
- ...including those that are byproducts of preventive treatments (such as trees, wood, brush, thinnings, chips, and slash)…
- any organic matter that is available on a renewable or recurring basis from non-Federal land… including

    (i) renewable plant material, including
        (I) feed grains;
        (II) other agricultural commodities;
        (III) other plants and trees"

One source of feedstock for the 60 biochar facilities proposed in the bill is identified as "excess biomass." It is defined to include:

(i) trees or tree waste on public land;
(ii) wood and wood wastes and residues; and
(iii) weedy plants and grasses (including aquatic, noxious, or invasive plants).

[American Power Act, S. xx, 111th Cong., § 2002 (2010) (amending Title VII of the Clean Air Act (42 U.S.C. 7401 et seq.) as added by American Power Act § 2001, by adding § 700 (44)]

Appendix B: Analysis and Methodology

We analyzed output from the NEMS model, using publicly available projections from EIA that forecast how the energy sector would likely develop if ACESA were enacted. EIA power development projections are reported for each of the 13 North American Electric Reliability Council (NERC) regions in the continental United States. We examined EIA's data on total generation, coal-fired generation and biomass power generation, as well as carbon dioxide emissions from the power sector.

EIA reports the gigawatts of capacity to be built, which refers to direct-fired plants, and the total kilowatt-hours of biomass power to be generated, which refers to both direct-fired and co-fired biomass power. EIA also models GW of capacity and kWh of generation for end-use facilities. We converted the proposed GW of direct-fired plants to be built to express the number of kWh of power that would be generated at direct-fired plants. We then subtracted that number from EIA's own estimate of the total number of kWh of power generated from biomass to estimate how much of that total generation would come from co-firing biomass in coal plants in each NERC region. We checked the summed totals from all the NERC regions against EIA's own reported values for co-firing and direct generation that are reported for the country as a whole. End use generation data was used as reported, in kilowatt-hours. We converted kilowatt-hours of power generated to BTUs using conversion factors provided by EIA.

Our analysis of biomass availability used the same basic input datasets as used by EIA. The data come from a 1999 Oak Ridge National Laboratory (ORNL) dataset on urban wood, mill residues, agricultural residues and forestry residues. EIA uses these raw data on supply availability to generate price/supply curves that take various factors into consideration, including transportation costs. We did not adjust the availability of residues on a cost basis, using the simplified assumption that residues are equivalently available within the region where they are needed, which likely overstates their actual availability. This is a conservative assumption in the context of our analysis because to the extent that we overstate the availability of non-forest sources of biomass, we understate the amount of forest biomass that will be needed to meet fuel demand.

EIA's final supply curves for forestry residues include not only logging residues as included in the ORNL dataset, but also a significant portion of the standing "cull" tree biomass from the Forest Service inventory. We confined our estimate of forest biomass availability to logging residues as defined by the Forest Service, only. While EIA's estimate of forest biomass is based on 1999 data, we instead used 2006 Forest Service data on logging residues that are on average 26 percent higher than the ORNL values from 1999 that EIA used. This analysis is conservative in the context of our analysis because the estimates of logging residues that we used are larger than EIA's estimates.

To estimate the amount of new forest cutting that would be needed to meet biomass fuel demand after other sources of biomass (including logging residues) were exhausted, we converted biomass power generation from kWh to BTUs, using EIA's own assumptions about fuel energy content and plant efficiency. We then estimated the amount of BTUs available from existing sources of biomass based on the limitations we imposed. The BTU "deficit" was then presumed to be made up by new forest cutting. We calculated the number of acres that would need to be cut by converting the BTU deficit to tons of wood, and then divided this value by the aboveground biomass per acre for forests of each NERC region, using Forest Service data on aboveground biomass.[87]

Fossil fuel use and CO_2 emissions from biomass transport

This analysis was conducted using a number of conservative assumptions. Fuel use during transport was calculated using numbers from a typical 50 MW plant. Fuel use depends on various factors, but we assumed that trucks carry about 25 tons each of wood chips and are primarily in the HDDV8B class (>60,000 lbs). We assumed an average round-trip fuel transport distance of 100 miles and that trucks get 6.2 mpg.[88]

Analysis of EIA's assumptions concerning biomass fuel availability

A number of assumptions are built into EIA's estimates of fuel availability and the configuration of NEMS. Our analysis identifies a range for potential availability of existing fuels.

"Urban wood" (Construction and demolition debris)

We used EIA's input data for urban wood availability, although the category is so broadly defined as to probably overstate actual availability. The data documentation itself expresses little confidence in the accuracy of the data: "Urban wood wastes include yard trimmings, site clearing wastes, pallets, wood packaging, and other miscellaneous commercial and household wood wastes that are generally disposed of at municipal solid waste (MSW) landfills, and demolition and construction wastes that are generally disposed of in construction/demolition (C/D) landfills. Data regarding quantities of these wood wastes is difficult to find and price information is even rarer."[89]

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87 Smith, et al 2007.

88 Texas Transportation Institute. 2007. A modal comparison of domestic freight transportation effects on the general public. December 2007; Amended March 2009. Houston, TX

89 Walsh, M., et al. 2000. Biomass feedstock availability in the United States: 1999 state level analysis. Prepared for EIA; available at http://bioenergy.ornl.gov/resourcedata/index.html. The document further adds, "Additionally, both the quantity and price of urban wastes are highly speculative. The analysis is based solely on one national study and regional averages taken from two additional surveys. There is no indication of the quality of the material present (i.e., whether the wood is contaminated with chemicals, etc.). Because of the ways in which the surveys were conducted, there may be double counting of some quantities (i.e., MSW may contain yard trimmings and C/D wastes as well). Additionally, the analysis assumes that the majority of this urban wood is available for a minimal fee, with much of the cost resulting from transportation. Other industries have discovered that once a market is established, these "waste materials" become more valuable and are no longer available at minimal price. This situation could also happen with urban wastes used for energy if a steady customer becomes available. It should also be noted however, that some studies indicate that greater

The modeling also likely overstates the usability of the urban wood stream because it assumes that a high percentage of urban wood is burnable but does not take into account the expense and difficulty of sorting this wood supply to remove pressure-treated lumber, which contains arsenic and chromium, as well as sources of contamination, such as painted wood, that can contain lead and other toxins. The analysis also does not take into account that sophisticated and expensive emissions control equipment may be required to control metals and dioxin emissions. Public opposition to combustion of this material can also be strong.[90] Because of these considerations, our analysis considered urban wood availability to be lower than that assumed by EIA. Our high level of availability was 75 percent of the EIA figure, approximately matching the proportion of "high grade" plus painted and stained wood found in a Massachusetts study of construction and demolition debris (this fuel stream would thus exclude most pressure-treated lumber, which contains chromium and arsenic, although fuel sorting studies demonstrate it is impossible to reduce the amount of this material in the fuel stream to zero).

Characterization of construction and demolition waste as a "renewable" or "carbon neutral" fuel is also objectionable,[91] particularly given that actual recycling and re-use of processed wood is a far "greener" use that actually saves the greenhouse gas costs of producing new materials.[92] Our low value for an availability factor for urban wood is thus 25 percent of EIA projections, which factors in public opposition to the use of this material as fuel.

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quantities of urban wastes are available, and are available at lower prices, than are assumed in this analysis. Given the high level of uncertainty surrounding the quantity and price estimates of urban wastes and mill residues, and the fact that these wastes are estimated to be the least cost feedstock available, they should be viewed with caution until a more detailed analysis is completed."

90 In response to concerns raised by citizens and the State Department of Public Health, Massachusetts declared a moratorium in December 11, 2009 on permitting for proposals to burn construction and demolition waste for power, pending a full environmental and health review. A week earlier, the Massachusetts Medical Society passed a resolution expressing the organization's opposition to large-scale biomass plants proposed in Massachusetts due to their "unacceptable public health risk", and encouraged the state to promote zero-pollutant emissions renewable energy technologies.

91 A memo from the Massachusetts Department of Environmental Protection regarding the recent application by the Somerset coal plant in Somerset, MA to repower the plant with construction and demolition waste states "MassDEP believes it is highly unlikely that Somerset Power could make an acceptable demonstration that construction and demolition is a source of carbon neutral fuel. It would be difficult, if not impossible, to have the information necessary to provide a reliable carbon neutral life-cycle analysis that includes consideration of material source, harvesting practices, transportation, impact of any coatings or treatments applied, and land use changes. At this time, it is unclear how such an analysis would even be done and evaluated." (Memo to Alicia McDevitt, Executive Office of Energy and Environmental Affairs, from David Johnston, Acting Regional Director, Southeast Regional Office/MassDEP. Sept. 22, 2009).

92 United States Environmental Protection Agency. Opportunities to reduce greenhouse gas emissions through materials and land management practices. Washington, DC. September 2009.

Mill residues

Mill residues include bark, coarse residues (chunks and slabs), and fine residues (shavings and sawdust). EIA uses data on mill residues and assumptions on end-use from 1997. For our re-analysis, we acquired mill residues data from 2006. According to the Forest Service,[93] only about 1.5 percent of current mill residues go unused, suggesting this is a negligible source of fuel for new biomass power capacity. We do not discount this source of material, however. Forest Service data estimate that about 42 percent of mill residues are currently used for power generation, therefore we include this material in our re-analysis of EIA data, acknowledging that it is mostly allocated to existing, end-use biomass power generation. We assume 42 percent availability for mill residues in both our low and high fuel availability scenarios.

Agricultural residues

The NEMS model assumes that about 150 million tons[94] of agricultural residues (primarily corn stover and wheat straw, but including other crop residues) are potentially available annually for biomass fuel, a number that assumes about 40 percent of material is collected[95] and 60 percent is left on the field to maintain soil fertility (earlier versions of EIA's model assumed that between 30 and 40 percent of agricultural residues should be left on the field[96]).

However, as documentation for the NEMS model itself states, the estimate of availability of agricultural residues is possibly a significant overestimate. Aside from the lack of equipment for collecting and processing agricultural residues for use as fuel, the goal of generating 36 billion gallons of biofuels by 2021 includes a mandate to produce 16 billion gallons from cellulosic sources, an end-use that directly competes with the allocation of agricultural residues for power generation. Recent projections by the EIA of actual production estimate that cellulose-based ethanol production will reach 5.11 billion gallons by 2035, with an additional 12.5 billion gallons of "liquids from biomass".[97] At a conversion efficiency of about 50 gallons ethanol per ton of material, the demand for cellulosic feedstock would be about 102 million tons, or about 68 percent of all the agricultural residues that EIA states are available.

Use of agricultural residues as biomass fuel is also limited by the amount of processing they require before they can be burned, particularly in coal plants where the fuel feeding apparatus cannot handle

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93 Smith et al, 2007.

94 The Union of Concerned Scientists used a similar estimate of agricultural residue availability of 158 million tons, which they state takes into account the need to leave some residues in the field to maintain soil fertility. Information from Union of Concerned Scientists, Climate Blueprint 2030, Appendix G, Biomass Energy Supply and Land-use Assumptions.

95 http://bioenergy.ornl.gov/papers/misc/resource_estimates.html

96 Haq, Z. 2002. Biomass for electricity generation. Energy Information Administration.

97 Voegele, E. 2009. EIA: Biofuels production to grow significantly, but short of RFS mandates. Biomass Magazine, December, 2009.

materials beyond a certain size and consistency. Further, the cost of processing and delivering these materials may be prohibitively high for their use as fuel without significant subsidies. A recent study[98] found that the cost of collecting, processing and delivering corn stover for energy was about $77 per ton, equating to more than the $50 price threshold for fuels modeled by NEMS on the basis of the 1987 dollar value. Our high availability scenario therefore is generous in assuming the availability of agricultural residues as biomass fuel could be 50 percent of the EIA estimate. Our low estimate assumed availability was 25 percent of the EIA estimate, reflecting the numerous constraints on use of these materials for biopower.

Logging residues

EIA's estimate of forest biomass availability not only overstates the actual supply that is available, but also depends on increased tree cutting, a trend that will increase greenhouse gas emissions. We confined our estimate of available forest biomass to logging residues generated by current forestry operations, which is the definition that the Forest Service uses. The presumption of carbon neutrality is based on the idea that having been cut, this material will decompose anyway, ultimately producing greenhouse gas emissions equivalent to those released if it is burned for energy, although the time scales of these two processes differ.

As defined by the U.S. Forest Service, forest residues include tree, tops, and unmarketable "cull" trees that are removed at current harvesting levels.[99] We used 2006 data on logging residues availability, which sums to about 56 million dry tons (EIA's estimates were based on 1999 data). Unlike EIA, we did not include standing "cull" trees or "excess small pole trees" in our estimate of forestry residues, since increased harvesting of this material would represent a new source of greenhouse gas emissions and does not fit under the assumption of carbon neutrality described above. We assumed that forest harvesting will remain relatively constant into the future and thus the supply of logging residues will be relatively constant.

Many forests of the United States are important sources of fuel wood for commercial and domestic heating, and about two thirds of the fuel wood used in the United States comes from sources that include cull trees cut during timber harvesting, and wood cut during land-clearing.[100] Thus, although some biomass fuel studies, such as that published by the National Renewable Energy Laboratory,[101] include wood from "cultural operations" (pre-commercial thinning for timber stand improvement)

98 Morey, V., et al. A biomass supply logistics system. Submitted for publication.

99 These data are presented in units of cubic feet. We converted volume to mass using the same conversion factor used in the National Renewable Energy Laboratory report on biomass availability (Milbrandt, 2005.)

100 Smith et al, 2007. "Other sources" is defined as "Sources of roundwood products that are nongrowing stock. These include salvable dead trees, rough and rotten trees, trees of noncommercial species, trees less than 5.0 inches d.b.h., tops, and roundwood harvested from nonforest land (e.g., fence rows)." This category of data is also included in EIA's estimates of biomass fuel for biopower applications.

101 Milbrandt, .2005.

and land clearing in their estimates of biomass availability, we confined our estimate to logging residues only, because wood from land-clearing appears to be already allocated to various uses, including fuel wood. In fact, the amount of fuel wood harvested annually in the United States[102] is about 77 percent of the amount of wood that is removed by cultural operations and land clearing. However, just as importantly, wood from permanent land clearing should not be considered a "renewable" biomass fuel, since re-growth and thus re-sequestration of carbon can never occur on permanently cleared land.

Other estimates of wood supply, such as that published in the joint report by the U.S. Department of Energy and the U.S. Department of Agriculture[103] assume that significant quantities of wood from "fuel reduction thinning" of forests of the western United States will also be available as biomass fuel. Reference is also sometimes made to the large amount of pine beetle-killed trees that exist in some regions of the West. We do not include these wood sources in our estimate of biomass availability. These removal programs are geographically limited, as yet largely speculative and would cause no less of a sudden pulse of carbon emissions than any other program of new tree harvesting would. Cutting of "overstocked" and beetle-killed wood for biomass fuel on the assumption that these trees may burn in the future ensures a 100 percent probability of near-term carbon emissions from these sources. Further, while all the biomass fed into a burner is combusted, recent research suggests that forest fire emissions are actually significantly less than had been assumed because so much standing timber remains after most fires.[104]

Earlier estimates from EIA assumed that 100 percent of logging residues generated by current logging is recoverable,[105] an assumption that not only overstates availability in terms of practical considerations, but also is an actual threat to forest sustainability. There are many constraints on the collection of logging residues for biomass fuel, including limited availability of the specialized equipment required for dragging material to a central chipping site, chipping and transport; accessibility of the land to this equipment; and collection and transport costs (green biomass chips are a low-value material and their removal is not cost-effective at many remote sites).

Retention of logging residues on site is also vital for maintaining forest health and sustainability. The tops and branches of trees are where the majority of nutrients reside; removing these from the site can lead to soil nutrient depletion, as well as leaving freshly logged areas open to erosion. Even the very optimistic joint U.S. Department of Agriculture/Department of Energy report on biomass

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102 Smith et al, 2007.

103 Perlack, et al. 2005. Biomass as feedstock for a bioenergy and bioproducts industry: the technical feasibility of a billion-ton annual supply. U.S. Department of Energy, DOE/GO-102995-2135, ORNL/TM-2005/66. Oak Ridge National Laboratory, Oak Ridge, TN.

104 C Meigs, G.W., et al. 2009. Forest Fire Impacts on Carbon Uptake, Storage, and Emission: The Role of Burn Severity in the Eastern Cascades, Oregon. Ecosystems 12: 1246–1267.

105 Walsh, M., et al. 2000.

availability informally known as the "Billion Ton Vision"[106] asserts that "not all of this material should be recovered. Some portion of this material, especially the leaves and part of tree crown mass, should be left on site to replenish nutrients and maintain soil productivity."

EIA's estimates of agricultural residue availability acknowledge that 40-to-60 percent of residues should be maintained on farm fields to maintain soil productivity, but no such guidelines have been stated for logging residues. Yet retaining these materials is just as important in forested systems, where fertilizer is not added to make up for nutrient losses in harvest, as in agricultural systems, where fertilizer can be used.

Due to the logistical constraints outlined above, we assume that the number of acres where biomass is collected will be smaller than the number logged and could range from 50-to-75 percent of logged acres, with a generous estimate being 60 percent.[107] We further assume that in those areas where logging residues *are* collected, a minimum of 60 percent of material should be left in place (allowing 40 percent to be removed) to retain nutrient stocks (this number matches the guideline for agricultural soil but is nonetheless only a hypothetical scenario, since it is too low to be properly protective of soil nutrient stocks in many soils). Thus, our estimate for availability of logging residues is calculated as 60 percent of harvested areas times 40 percent of residues collected, equaling 24 percent.

This estimate of logging residues availability does not even take into consideration the considerable competing demands for wood that may be presented by the pellet industry, which is already shipping pellets internationally, or for wood used in cellulosic ethanol production. As observed in a research brief by Resources for the Future, wood is likely to be used for meeting mandated production levels of cellulosic ethanol, for "while grasses and other crops could prove to be a feasible long-term alternative, in the near term the onus of meeting the mandated targets would probably fall on wood because large inventories of wood and an infrastructure currently exist for harvest and transport; these are not available for grasses… It is clear that the timber harvest levels needed to supply both the conventional forest products industry and the new biofuel industry would be huge. For example, given commonly used conversion factors for wood to ethanol, the wood required for the targeted 2022 biofuel feedstock would need to equal to 348 million cubic meters (m^3) or 71 percent of the 2005 harvest of 489 million m^3." [108]

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106 Perlack, et al. 2005.

107 According to the Forest Service, 39 percent of forest harvesting is clearcutting. We assume that up to 75 percent of this land could be available for residue collection. The remaining 61 percent of harvested lands are likely less accessible, thus we assume 50 percent accessibility. The weighted accessibility value is thus 60 percent.

108 Sedjo, R.A. and Sohngen, B. The implications of increased use of wood for biofuel production. Issue Brief # 09-04, June 2009. Resources for the Future, Washington, DC.

Energy crops

EIA assumes energy crops can be grown to meet biomass power needs. Some energy crops would displace crops currently grown on agricultural land, and some would be grown on currently idled land and Conservation Reserve lands. However, production costs for energy crops may prove to be prohibitive to their use as biomass fuel. A recent five-year study of farmers growing switchgrass found that on average, production costs were nearly $60/ton dry matter. For a typical 50 MW biomass plant, the production cost of the fuel prior to any transport or further processing (such as pelletizing) would thus be more than $19 million, two to three times the cost of wood chips. Given these costs, energy crops may provide a better financial return as biofuel feedstock, especially given the mandate for cellulosic ethanol production.

Virtually no energy crops of significance are being grown today, and our analysis does not attempt to modify EIA assumptions about fuel available from this resource. Instead, by estimating the gap between projected biomass power fuel needs and fuel availability, we calculate both the number of forest acres that would need to be harvested to make up the gap, and also the number of acres that would need to be planted with energy crops if the fuel deficit were to be made up that way. We use switchgrass as a "model" energy crop, assuming yields of 7 tons per acre, a generous estimate given previous estimates of switchgrass yields at 5 tons per acre.[109]

How did we translate BTUs of biomass energy into acres of forest cut?

Example calculation

EIA projects that under a federal renewables standard, the United States will generate 227 billion kWh of power from biomass in 2015.

Taking into account average power plant efficiencies for direct-fired biomass plants, coal plants where biomass is co-fired, and end-use generators, the 227 billion kWh translates into a need to generate 3,338,858,691 MMBTUs (million British thermal units) from biomass in 2015.

How many MMBTUs could be available from various sources of biomass in 2015?

Tons of urban wood available 9,211,654 — (158,440,449 MMBTUs)
Tons of mill waste available 37,975,560 — (653,179,632 MMBTUs)
Tons of agricultural waste available 37,662,851 — (580,007,905 MMBTUs)
Tons of logging residues available 13,549,180 — (233,045,896 MMBTUs)

Total: 1,624,673,882 BTUs can be generated from sources of biomass that are presumed available,

109 Natural Resources Defense Council, 2004. Growing Energy: how biofuels can help end America's oil dependence. Washington, DC.

leaving a deficit of 1,714,184,809 MMBTUs that could be made up with new forest cutting, or energy crops.

BTUs per ton of forest biomass: 17,200,000
BTUs per ton of switchgrass: 15,400,000

Therefore, 1,714,184,809 MMBTUs could be generated by harvesting and burning 99,661,907 tons of dry wood, or 111,310,702 tons of an energy crop like switchgrass.

Tons of dry forest biomass per acre: 45
Tons of switchgrass per acre: 7

Burning 99,661,907 tons of dry wood would require the equivalent of clearcutting 2,214,709 acres of forest. Burning 111,310,702 tons of an energy crop such as switchgrass would require harvesting 15,901,529 acres.

Other assumptions of EIA modeling

The EIA modeling assumes that available biomass fuels are consumed in the order of least expensive to most expensive, so that "urban wood" (primarily construction and demolition wood, or C&D) and mill waste are used first, agricultural residues are next, then forestry residues, and finally energy crops.

This may make sense from a modeling point of view, but it is not the case in reality. The plants that are currently permitted to burn construction and demolition waste wood are mostly in Maine and have had difficulty meeting emissions standards, as all were originally designed to burn only forest wood and only later began burning C&D as forest wood supplies tightened. Permitting for a direct-fired biomass plant that was proposed in Massachusetts to burn 80 percent C&D waste and 20 percent forest biomass, and also for a proposal to repower a coal plant using up to 100 percent C&D waste, was suspended by the state pending completion of a state-wide environmental and health study. The C&D burning biomass plant proposed to install more sophisticated and expensive emissions control equipment than generally used on such plants, but still would have had unacceptably high emissions of arsenic, chromium, and dioxins,[110] as well as criteria air pollutants. The Massachusetts Bureau of Environmental Health became involved, expressing concerns about placement of a combustion power source in the environmental justice community of Springfield, Mass.[111]

110 Letter on Palmer Renewable Energy proposed Beneficial Use Determination from Massachusetts Environmental Energy Alliance to Massachusetts Department of Environmental Protection, November 18, 2009. Available at www.massenvironmentalenegy.org.

111 Letter from Suzanne Condon, Director, Massachusetts Bureau of Environmental Health, to Daniel Hall, Executive Office of Energy and Environmental Affairs, November 19, 2009. Available at www.massenvironmentalenergy.org.

Relevant to emissions of carbon dioxide, EIA modeling with NEMS also assumes that all direct-fired biomass plants built in the future will use gasification technology,[112] rather than direct combustion, and that plant efficiency at both biomass plants and coal plants will increase over time. The assumption that gasification technology will be used decreases projected fuel needs relative to conventional boilers. However, as EIA model documentation acknowledges, relatively few gasification plants exist, and capital costs for this technology are highly uncertain.[113] A review of recently proposed biomass co-firing and direct-fired proposals finds a minority of projects plan to use gasification. The result is that EIA's estimates of the conversion efficiency of biomass to power are likely overestimated, and that fuel needs are thus underestimated. For utility scale direct-fired plants, we assumed an efficiency of 30 percent, which is on the high end of the range for direct-fired plants that use conventional combustion technology,[114] the technology that will constitute the overwhelming majority of biomass power plants for years to come. For end-use generators, such as paper mills that generate power with waste materials, we assumed 25 percent efficiency. For biomass co-fired at coal plants, we assumed an average efficiency for the coal fleet of 33 percent. To the extent that we have overestimated efficiency, we have underestimated biomass fuel needs and potential impacts.

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112 Online documentation for the NEMS model states, "The conversion technology represented, upon which the costs in Table 8.3 in the EMM chapter are based, is an advanced gasification-combined cycle plant that is similar to a coal-fired gasifier" (from http://www.eia.doe.gov/oiaf/aeo/assumption/renewable.html). Other documentation states, "Finally, EIA assumes the use of biomass gasification technology for dedicated biomass generation plants. Based on current estimates, these plants trade off somewhat higher capital costs for significantly improved efficiency compared to direct-combustion technology, thus reducing operating costs. However, few commercial biomass gasification operations currently exist, and capital costs for this technology are highly uncertain." Energy Information Administration, Office of Integrated Analysis and Forecasting. Model documentation: Renewable fuels module of the National Energy Modeling System. DOE/EIA-M069(2009). July, 2009. Washington, DC.

113 Energy Information Administration. Impacts of a 25-percent renewable electricity standard as proposed in the American Clean Energy and Security Act Discussion Draft. SR/OIAF/2009-04. April, 2009. Washington, DC.

114 For instance, review of specifications for the proposed 50 MW Russell Biomass plant in Massachusetts reveal that the plant will operate at 24 percent efficiency, far below the average efficiency factor of 30 percent that we have estimated for biomass power plants.